Supporting Information for

A Synthetic Strategy toward Eight-Membered Cyclic Amines by Cycloetherification and Claisen Rearrangement

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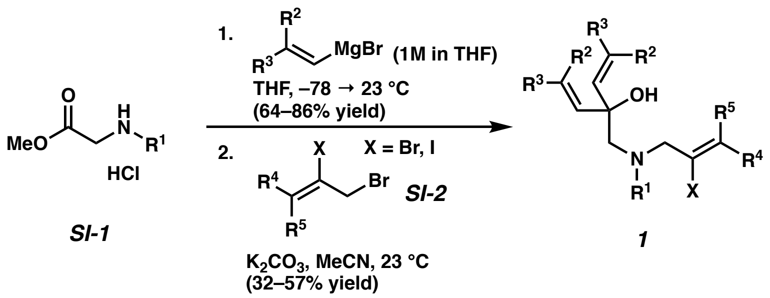
Materials and Methods

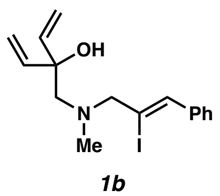
Unless otherwise stated, reactions were performed in flame-dried glassware under an argon or nitrogen atmosphere using dry, deoxygenated solvents. Reaction progress was monitored by thin-layer chromatography (TLC). THF, Et_2O, CH_2Cl_2, toluene, benzene, CH_3CN, and dioxane were dried by passage through an activated alumina column under argon. Purified water was obtained using a Barnstead NANOpure Infinity UV/UF system. Brine solutions are saturated aqueous solutions of sodium chloride. Commercially available reagents were purchased from Sigma-Aldrich, Acros Organics, Strem, or Alfa Aesar and used as received unless otherwise stated. Reaction temperatures were controlled by an IKAmag temperature modulator unless otherwise indicated. Glove box manipulations were performed under a N_2 atmosphere. TLC was performed using E. Merck silica gel 60 F254 precoated glass plates (0.25 mm) and visualized by UV fluorescence quenching, *p*-anisaldehyde, $KMnO_4$ or PMA (phosphomolybdic acid) staining. Silicycle Silia*Flash* P60 Academic Silica gel (particle size 0.040-0.064 mm) was used for flash column chromatography. ^1H NMR spectra were recorded on a Varian Inova 300 MHz, 500 MHz and 600 MHz and Bruker 400 MHz spectrometers. The ^1H NMR spectra are reported relative to residual $CHCl_3$ (δ 7.26 ppm), C_6D_6 (δ 7.16 ppm) or CD_3OD (δ 3.31 ppm). ^{13}C NMR spectra are recorded on a Varian Inova 300 MHz (75 MHz) and 500 MHz spectrometer (125 MHz) and Bruker 400 MHz spectrometers (100 MHz). The ^{13}C NMR spectra are reported relative to $CHCl_3$ (δ 77.16 ppm), C_6D_6 (δ 128.06 ppm), or CD_3OD (δ 49.01 ppm). Data for ^1H NMR are reported as follows: chemical shift (δ ppm) (multiplicity, coupling constant (Hz), integration). Multiplicities are reported as follows: s = singlet, d = doublet, t = triplet, q = quartet, p = pentet, sept = septuplet, m = multiplet, br s = broad singlet, br d= broad doublet, app = apparent. Data for ^{13}C NMR are reported in terms of chemical shifts (δ ppm). IR spectra were obtained using a Perkin Elmer Paragon 1000 spectrometer using thin films deposited on NaCl plates and reported in frequency of absorption (cm^{-1}). High resolution mass spectra (HRMS) were obtained from the Caltech Mass Spectral Facility using JEOL JMS-600H High Resolution Mass Spectrometer in fast atom bombardment (FAB+) or electron ionization (EI+) mode, or using an Agilent 6200 Series TOF with an Agilent G1978A Multimode source in electrospray ionization (ESI+), atmospheric pressure chemical ionization (APCI+), or mixed ionization mode (MM: ESI-APCI+).

Representative procedure for aminoalcohols 1



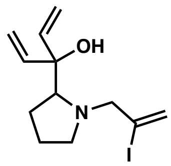
To a solution of ester **SI-1** (3.58 mmol, 1.00 equiv) in THF (18.0 mL) was added vinylmagnesium bromide (1 M in THF) (17.9 mmol, 5.00 equiv) dropwise at –78 °C. The solution was stirred for 12 h at 23 °C. The solution was quenched with sat. NH_4Cl at 0 °C. The aqueous phase was washed with Et_2O (3 x 20.0 mL). The combined organic phase was washed with brine, dried over anhydrous $MgSO_4$, and concentrated *in vacuo*. The residue was purified by flash column chromatography on silica gel to give tertiary alcohols.

To a solution of tertiary alcohol (1.38 mmol, 1.00 equiv) in MeCN (6.90 mL) were added K_2CO_3 (6.90 mmol, 5.00 equiv) and allyl bromide **SI-2** (1.45 mmol, 1.05 equiv). The solution was stirred for 12 h at 23 °C. After the reaction was completed, water was added. The aqueous phase was washed with EtOAc (3 x 6.00 mL). The combined organic phases were washed with brine, dried over anhydrous $MgSO_4$, and concentrated *in vacuo*. The residue was purified by flash column chromatography on silica gel to give aminoalcohols **1**.



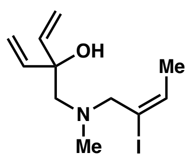
1b

1b (178 mg, 0.482 mmol) was synthesized from sarconic methyl ester hydrochloride (193 mg, 1.38 mmol); 35% yield (2 steps); R_f = 0.25 (1:8 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 – 7.48 (m, 2H), 7.41 – 7.31 (m, 3H), 6.96 (s, 1H), 5.93 (dd, *J* = 17.3, 10.6 Hz, 2H), 5.41 (d, *J* = 17.3 Hz, 2H), 5.16 (d, *J* = 10.7 Hz, 2H), 4.14 (s, br, 1H), 3.45 (s, 2H), 2.69 (s, 2H), 2.32 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.0, 137.4, 136.2, 128.8, 128.8, 128.3, 114.0, 107.4, 74.5, 71.8, 66.0, 43.1; IR (Neat Film NaCl) 2846, 2792, 2361, 2343, 1447, 999, 921, 750, 695 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{16}H_{21}OIN$ $[M+H]^+$: 370.0662; found: 370.0688.



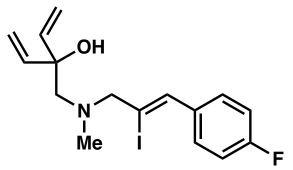
1c

1c (117 mg, 0.367 mmol) was synthesized from proline methyl ester hydrochloride (145 mg, 0.875 mmol); 42% yield (2 steps); R_f = 0.55 (1:8 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.28 (dt, *J* = 2.1, 1.1 Hz, 1H), 5.93 (dd, *J* = 17.2, 10.6 Hz, 1H), 5.86 (dd, *J* = 17.3, 10.8 Hz, 1H), 5.80 (t, *J* = 1.5 Hz, 1H), 5.45 (dd, *J* = 17.2, 1.5 Hz, 1H), 5.32 (dd, *J* = 17.3, 1.6 Hz, 1H), 5.12 (ddd, *J* = 11.5, 10.7, 1.6 Hz, 2H), 3.75 (dt, *J* = 14.2, 1.8 Hz, 1H), 3.60 (s, 1H), 3.08 – 3.00 (m, 1H), 2.95 – 2.85 (m, 2H), 2.33 – 2.22 (m, 1H), 1.92 – 1.81 (m, 1H), 1.83 – 1.53 (m, 4H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 142.6, 140.1, 125.7, 113.7, 113.2, 112.4, 69.6, 67.8, 54.6, 27.9, 24.5; IR (Neat Film NaCl) 2964, 2871, 2799, 1617, 1409, 1355, 1114, 998, 920 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{12}H_{19}ONI$ $[M+H]^+$: 320.0506; found: 320.0512.



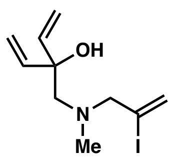
1d

1d (88.8 mg, 0.289 mmol) was synthesized from sarconic methyl ester hydrochloride (115 mg, 0.826 mmol); 35% yield (2 steps); R_f = 0.35 (1:8 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.42 (qt, J = 7.2, 1.2 Hz, 1H), 5.92 (d, J = 10.7 Hz, 1H), 5.87 (d, J = 10.7 Hz, 2H), 5.39 (dd, J = 17.2, 1.5 Hz, 2H), 5.13 (dd, J = 10.6, 1.5 Hz, 2H), 4.17 (s, 1H), 3.16 (s, 2H), 2.62 (s, 2H), 2.24 (s, 3H), 1.71 (dt, J = 7.0, 0.8 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.1, 138.7, 113.9, 102.8, 74.4, 66.0, 62.3, 43.0, 17.1; IR (Neat Film NaCl) 2948, 2846, 1452, 1303, 1112, 1039, 996, 922 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{11}H_{19}ONI$ $[M+H]^+$: 308.0506; found: 308.0517.



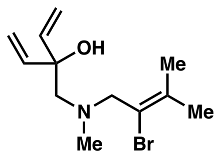
1e

1e (158 mg, 0.408 mmol) was synthesized from sarconic methyl ester hydrochloride (130 mg, 0.928 mmol); 44% yield (2 steps); R_f = 0.35 (1:8 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 – 7.44 (m, 2H), 7.10 – 6.99 (m, 2H), 6.91 (s, 1H), 5.92 (dd, J = 17.3, 10.7 Hz, 2H), 5.40 (dd, J = 17.3, 1.5 Hz, 2H), 5.15 (dd, J = 10.7, 1.5 Hz, 2H), 4.09 (s, 1H), 3.42 (s, 2H), 2.69 (s, 2H), 2.31 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 162.5 (d, J = 248.2 Hz), 142.0, 135.0, 133.4 (d, J = 3.4 Hz), 130.7 (d, J = 8.1 Hz), 115.3 (d, J = 21.6 Hz), 114.0, 107.7, 74.6, 71.8, 66.0, 43.2; ^{19}F NMR (282 MHz, $CDCl_3$) δ -112.9; IR (Neat Film NaCl) 2848, 2360, 2342, 1601, 1506, 1227, 1158, 997, 923 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{16}H_{20}ONIF$ $[M+H]^+$: 388.0568; found: 388.0578.



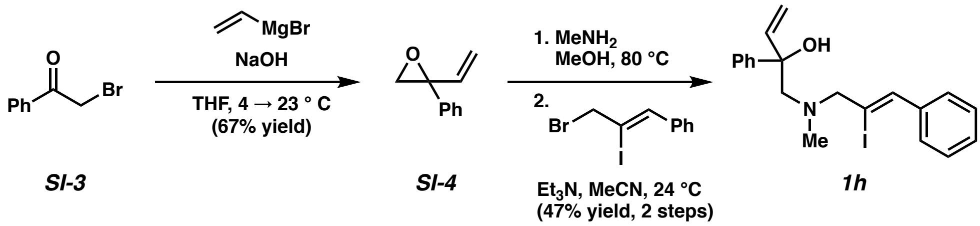
1f

1f (61.3 mg, 0.209 mmol) was synthesized from sarconic methyl ester hydrochloride (122 mg, 0.873 mmol); 24% yield (2 steps); R_f = 0.35 (1:8 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.27 (q, J = 1.4 Hz, 1H), 5.92 (d, J = 10.6 Hz, 2H), 5.92 – 5.83 (m, 3H), 5.39 (dd, J = 17.3, 1.5 Hz, 2H), 5.14 (dd, J = 10.7, 1.5 Hz, 2H), 4.03 (s, 1H), 3.14 (s, 2H), 2.63 (s, 2H), 2.26 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.9, 127.3, 114.0, 111.9, 74.4, 70.0, 66.0, 43.2; IR (Neat Film NaCl) 2917, 2848, 2791, 1617, 1451, 1406, 1304, 1154, 1117, 1038, 996, 992 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{10}H_{17}ONI$ [M+H]$^+$: 294.0349; found: 294.0364.



1g

1g (106 mg, 0.385 mmol) was synthesized from sarconic methyl ester hydrochloride (110 mg, 0.786 mmol); 49% yield (2 steps); R_f = 0.35 (1:8 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 5.89 (dd, J = 17.3, 10.7 Hz, 2H), 5.37 (dd, J = 17.3, 1.6 Hz, 2H), 5.12 (dd, J = 10.6, 1.5 Hz, 2H), 3.40 (s, 2H), 2.60 (s, 2H), 2.27 (s, 3H), 1.91 (s, 3H), 1.83 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 142.3, 134.9, 119.8, 113.7, 74.1, 65.9, 62.9, 43.0, 25.8, 21.2; IR (Neat Film NaCl) 2918, 2846, 1458, 1410, 1364, 1305, 1040, 998, 922 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{12}H_{21}ONBr$ [M+H]$^+$: 274.0801; found: 274.0826.



A 500 mL flame-dried round bottom flask, equipped with a stir bar, was placed under an argon atmosphere. Vinyl magnesium bromide (1 M in THF, 26.0 mL, 26.0 mmol) was charged to the reaction vessel. After cooling the solution for 10 min at 4 °C, 2-bromo-1-phenylethanone (3.50 g, 17.2 mmol) in THF (88.0 mL) was added slowly. Then, aq. NaOH (1 M, 80.0 mL, 80.0 mmol) was poured into the reaction pot at 4 °C. The reaction mixture was allowed to warm to 23 °C and stirred for 2 h. Water (50.0 mL) and EtOAc (40.0 mL) were added. Additional extract was obtained using EtOAc (2 x 50 mL). The combined organic layers were washed with brine (250 mL), dried over anhydrous sodium sulfate, filtered, and concentrated for purification. The residue was purified using basic alumina with EtOAc/Petroleum ether (1:50) to obtain 2-phenyl-2-vinyloxirane (1.68 g, 67% yield).

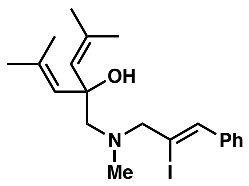
2-Phenyl-2-vinyloxirane (800 mg, 5.47 mmol), methyl amine (2 M in THF, 3.60 mL, 7.20 mmol), and MeOH (3.20 mL) were combined in 20 mL vial with a stir bar. The vial was heated at 80 °C *via* heating block for 12 h. The vial was allowed to cool to 23 °C. Solvent was removed under reduced pressure and placed on high vacuum for 10 min to afford an aminoalcohol.

To the residue were added MeCN (8.00 mL), Et_3N (2.00 mL, 14.0 mmol), and (*Z*)-(3-bromo-2-iodoprop-1-en-1-yl)benzene (1.58 g, 4.89 mmol). After 11.5 h, solvent was removed under reduced pressure and purified by silica gel chromatography to give (*Z*)-1-((2-iodo-3-phenylallyl)(methyl)amino)-2-phenylbut-3-en-2-ol (1.07 g, 47% 2-step yield) as an orange oil.[1]

R_f = 0.59 (1:4 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 – 7.47 (m, 4H), 7.40 – 7.31 (m, 5H), 7.27 – 7.22 (m, 1H), 6.93 (s, 1H), 6.21 (dd, *J* = 17.1, 10.6 Hz, 1H), 5.46 (dd, *J* = 17.0, 1.5 Hz, 1H), 5.16 (dd, *J* = 10.6, 1.5 Hz, 1H), 4.74 (s, 1H), 3.43 (dd, *J* = 13.4, 1.2 Hz, 1H), 3.29 (dd, *J* = 13.4, 1.2 Hz, 1H), 3.04 – 2.96 (m, 2H), 2.19 (s,

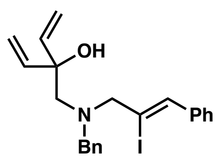
[1] Cheng, Q.; Zhang, H.-J.; Yue, W.-J.; You, S.-L. *Chem*. **2017**, *3*, 428–436.

3H).; ^{13}C NMR (126 MHz, $CDCl_3$) δ 145.5, 143.7, 137.4, 136.3, 128.8, 128.4, 128.3, 128.2, 126.8, 125.3, 113.6, 107.2, 74.9, 71.7, 67.5, 42.8; IR (Neat Film NaCl) 3468, 2953, 2928, 2857, 1617, 1465, 1378, 1255, 1154, 1086, 991, 921, 903 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{20}H_{23}INO$ $[M+H]^+$: 420.0830; found: 420.0844.



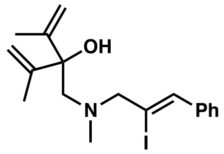
1i

1i (214 mg, 0.502 mmol) was synthesized from sarconic methyl ester hydrochloride (350 mg, 2.51 mmol); 20% yield (2 steps); R_f = 0.38 (1:8 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 – 7.50 (m, 2H), 7.35 (tdd, J = 8.7, 7.4, 3.7 Hz, 3H), 6.96 (s, 1H), 5.40 (dt, J = 2.7, 1.3 Hz, 2H), 3.47 (s, 2H), 2.71 (s, 2H), 2.35 (s, 3H), 1.76 (d, J = 1.3 Hz, 6H), 1.71 (d, J = 1.4 Hz, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.5, 135.9, 133.7, 131.8, 131.1, 128.9, 128.2, 107.7, 73.5, 72.4, 68.0, 43.1, 26.8, 19.8; IR (Neat Film NaCl) 2913, 2790, 1446, 1374, 1083, 1030, 750, 695 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{20}H_{29}ONI$ $[M+H]^+$: 426.1288; found: 426.1290.



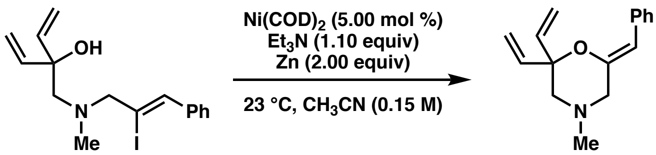
1j

1j (67.7 mg, 0.152 mmol) was synthesized from methyl 2-(benzylamino)acetate (75.8 mg, 0.423 mmol); 36% yield (2 steps); R_f = 0.38 (1:8 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.44 (m, 2H), 7.39 – 7.29 (m, 8H), 6.95 (s, 1H), 5.90 (dd, J = 17.2, 10.6 Hz, 2H), 5.40 (dd, J = 17.2, 1.5 Hz, 2H), 5.13 (dd, J = 10.6, 1.5 Hz, 2H), 3.82 (s, 1H), 3.78 (s, 2H), 3.56 (s, 2H), 2.80 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.1, 137.9, 137.6, 137.1, 129.7, 128.8, 128.5, 128.3, 127.6, 114.1, 106.8, 74.4, 67.4, 62.0, 58.8, 29.9; IR (Neat Film NaCl) 2916, 2849, 1250, 869, 696 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{22}H_{25}ONI$ $[M+H]^+$: 446.0975; found: 446.0984.



1k

1k (200 mg, 0.504 mmol) was synthesized from sarconic methyl ester hydrochloride (306 mg, 2.19 mmol); 23% yield (2 steps); R_f = 0.34 (1:8 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 – 7.48 (m, 2H), 7.41 – 7.27 (m, 3H), 6.96 (s, 1H), 5.12 (s, 2H), 4.97 (s, 2H), 4.63 (s, 1H), 3.42 (s, 2H), 2.96 (s, 2H), 2.28 (s, 3H), 1.71 (s, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 147.3, 137.4, 136.2, 128.8, 128.3, 111.8, 107.5, 71.8, 61.8, 42.5, 18.9; IR (Neat Film NaCl) 2953, 2849, 2792, 1640, 1446, 1369, 1309, 1067, 1017, 898, 750, 695 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{18}H_{25}ONI$ $[M+H]^+$: 398.0975; found: 398.0981.

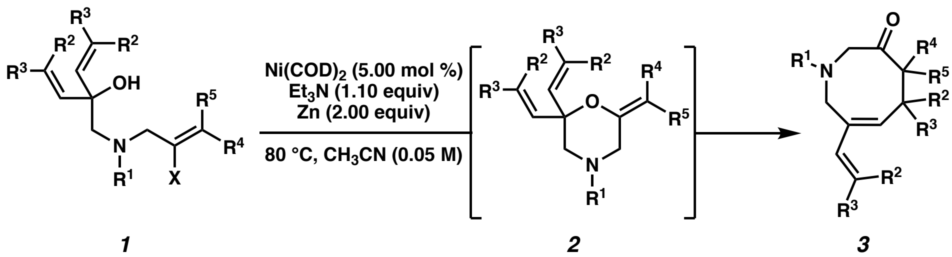


1b *2b*

Ni-catalyzed C–O bond formation experiments were performed in a nitrogen-filled glove box. To a solution of aminoalcohol **1b** (46.3 mg, 0.125 mmol, 1.00 equiv) in MeCN (0.830 mL) in a scintillation vial were added Et_3N (19 μL, 0.138 mmol, 1.10 equiv), Zn powder (16.3 mg, 0.250 mmol, 2.00 equiv), and $Ni(COD)_2$ (1.70 mg, 0.00627 mmol, 0.05 equiv). The reaction mixture was stirred at 23 °C for 24 h. After the reaction was completed, the vial was removed from the glove box and uncapped. Solids were removed *via* filtration through a celite plug, and the resulting solution was concentrated under reduced pressure. The residue was purified by flash column chromatography (1:4 EtOAc:hexanes) to give morpholine **2b** (22.3 mg, 74% yield).

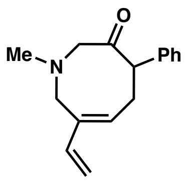
R_f = 0.35 (1:4 EtOAc:hexanes); ^{1}H NMR (400 MHz, CD_2Cl_2) δ 7.68 – 7.61 (m, 2H), 7.28 (dd, J = 8.4, 7.1 Hz, 2H), 7.16 – 7.11 (m, 1H), 5.93 (dd, J = 17.4, 10.9 Hz, 2H), 5.47 (s, 1H), 5.31 (dd, J = 17.4, 1.2 Hz, 2H), 5.17 (dd, J = 10.9, 1.2 Hz, 2H), 3.05 – 2.98 (s, 2H), 2.58 (s, 2H), 2.26 (s, 3H); ^{13}C NMR (101 MHz, CD_2Cl_2) δ 149.4, 139.8, 136.5, 128.9, 128.7, 126.3, 115.4, 108.0, 81.5, 62.8, 58.4, 46.3; IR (Neat Film NaCl) 2941, 2782, 1663, 1449, 1360, 1345, 1178, 1142, 983, 925, 754, 695 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{16}H_{20}ON$ $[M+H]^+$: 242.1539; found: 242.1564.

Representative procedure for the one-pot cycloetherification and Claisen rearrangement of tertiary alcohols



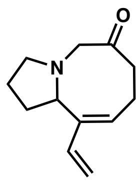
Experiments were performed in a nitrogen-filled glove box. To a solution of aminoalcohol **1** (0.0934 mmol, 1.00 equiv) in MeCN (1.90 mL) in a scintillation vial were added Et_3N (14.3 μL, 0.103 mmol, 1.10 equiv), Zn powder (12.2 mg, 0.187 mmol, 2.00 equiv), and $Ni(COD)_2$ (0.00467 mmol, 0.05 equiv). The reaction mixture was stirred at 80 °C for 24 h. After the reaction was completed, the vial was removed from the glove box and uncapped. Solids were removed *via* filtration through a celite plug, and the resulting solution was concentrated under reduced pressure. The residue was purified by flash column chromatography to give hexahydroazocine **3**.

Note: Due to the COVID-19 pandemic, we are unable to conduct this experiment on a 1 mmol scale due to limitations in our experimental lab in terms of capacity and personnel.



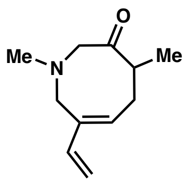
3b

3b (11.0 mg, 0.0454 mmol) was synthesized from **1b** (20.0 mg, 0.0541 mmol); 84% yield; R_f = 0.55 (1:2 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.39 (m, 2H), 7.38 – 7.32 (m, 2H), 7.31 – 7.26 (m, 1H), 6.30 (ddd, *J* = 17.7, 11.0, 0.8 Hz, 1H), 6.00 – 5.89 (m, 1H), 5.16 (d, *J* = 17.7 Hz, 1H), 5.01 (dt, *J* = 11.0, 0.7 Hz, 1H), 3.97 – 3.82 (m, 2H), 3.63 – 3.52 (m, 1H), 3.44 – 3.29 (m, 2H), 2.93 – 2.81 (m, 1H), 2.54 (ddd, *J* = 9.9, 7.9, 4.3 Hz, 1H), 2.44 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 210.0, 139.6, 138.1, 136.8, 131.8, 128.9, 128.0, 127.6, 112.3, 65.4, 60.8, 56.2, 46.0, 29.2; IR (Neat Film NaCl) 2939, 1702, 1452, 902, 765, 701 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{16}H_{20}ON$ $[M+H]^+$: 242.1539; found: 242.1548.



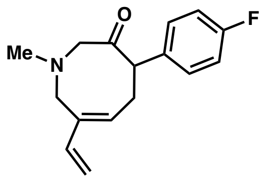
3c

3c (4.20 mg, 0.0219 mmol) was synthesized from **1c** (10.6 mg, 0.0332 mmol); 66% yield; R_f = 0.35 (1:8 EtOAc:hexanes); ^{1}H NMR (400 MHz, CD_2Cl_2) δ 6.19 (dd, *J* = 17.7, 11.1 Hz, 1H), 5.74 (t, *J* = 8.9 Hz, 1H), 5.07 (d, *J* = 17.7 Hz, 1H), 4.93 (d, *J* = 11.2 Hz, 1H), 4.15 – 4.01 (m, 1H), 3.59 (d, *J* = 16.1 Hz, 1H), 3.19 (td, *J* = 8.4, 2.0 Hz, 1H), 3.05 (dd, *J* = 9.7, 7.6 Hz, 1H), 2.89 (ddd, *J* = 14.0, 7.7, 1.7 Hz, 1H), 2.82 (dd, *J* = 16.1, 1.9 Hz, 1H), 2.39 (dddd, J = 13.9, 11.8, 7.6, 2.0 Hz, 1H), 2.30 – 2.19 (m, 2H), 1.99 (dddd, J = 12.2, 8.8, 7.6, 1.6 Hz, 1H), 1.87 (m, J = 12.8, 11.2, 9.5, 8.0, 5.0 Hz, 1H), 1.81 – 1.70 (m, 1H), 1.64 (dddd, J = 12.5, 11.2, 9.7, 5.7 Hz, 1H); ^{13}C NMR (101 MHz, CD_2Cl_2) δ 212.5, 140.6, 139.8, 131.7, 111.9, 67.4, 67.4, 56.1, 53.5, 43.4, 33.4, 23.2, 22.7; IR (Neat Film NaCl) 2945, 2798, 1706, 1222, 895 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{12}H_{18}ON$ $[M+H]^+$: 192.1383; found: 192.1383.



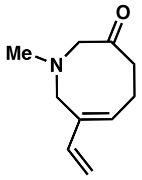
3d

3d (7.30 mg, 0.0410 mmol) was synthesized from **1d** (20.0 mg, 0.0651 mmol); 63% yield; R_f = 0.25 (1:4 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.27 (ddd, J = 17.5, 10.9, 0.8 Hz, 1H), 5.91 (t, J = 8.5 Hz, 1H), 5.18 (dt, J = 17.6, 0.7 Hz, 1H), 4.99 (dt, J = 10.8, 0.8 Hz, 1H), 3.42 – 3.26 (m, 2H), 3.17 (d, J = 2.1 Hz, 2H), 2.78 – 2.67 (m, 1H), 2.67 – 2.53 (m, 2H), 2.46 (s, 3H), 1.14 (d, J = 6.7 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 213.7, 139.5, 137.2, 132.2, 112.4, 64.0, 54.0, 48.8, 45.4, 31.1, 16.4; IR (Neat Film NaCl) 2969, 2931, 1702, 1451, 898 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{11}H_{18}ON$ $[M+H]^+$: 180.1383; found: 180.1386.



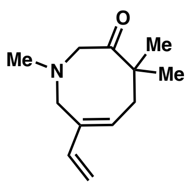
3e

3e (9.50 mg, 0.0368 mmol) was synthesized from **1d** (25.0 mg, 0.0646 mmol); 57% yield; R_f = 0.27 (1:4 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.41 – 7.35 (m, 2H), 7.07 – 7.01 (m, 2H), 6.28 (ddd, J = 17.7, 11.0, 0.8 Hz, 1H), 5.99 – 5.88 (m, 1H), 5.16 (d, J = 17.6 Hz, 1H), 5.01 (dt, J = 11.0, 0.7 Hz, 1H), 3.91 – 3.79 (m, 2H), 3.54 (dt, J = 15.1, 1.2 Hz, 1H), 3.35 – 3.27 (m, 2H), 2.89 (dt, J = 15.6, 0.7 Hz, 1H), 2.59 – 2.49 (m, 1H), 2.43 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 210.1, 162.2 (d, J = 246.2 Hz), 139.5, 136.9, 134.0 (d, J = 3.3 Hz), 131.4, 129.7 (d, J = 8.2 Hz), 115.7 (d, J = 21.1 Hz), 112.4, 65.6, 59.9, 56.5, 46.2, 29.5; ^{19}F NMR (282 MHz, $CDCl_3$) δ -115.2; IR (Neat Film NaCl) 2929, 1702, 1508, 1224, 1160, 832 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{16}H_{19}ONF$ $[M+H]^+$: 260.1445; found: 260.1449.



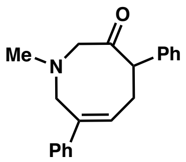
3f

3f (5.30 mg, 0.0321 mmol) was synthesized from **1f** (20.0 mg, 0.0682 mmol); 47% yield; R_f = 0.30 (1:2 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.28 (ddd, J = 17.6, 11.0, 0.8 Hz, 1H), 5.92 (tq, J = 8.5, 0.8 Hz, 1H), 5.18 (dt, J = 17.5, 0.7 Hz, 1H), 5.02 – 4.97 (m, 1H), 3.36 (s, 2H), 3.16 (s, 2H), 2.72 (dt, J = 8.6, 6.9 Hz, 2H), 2.58 (dd, J = 7.8, 5.8 Hz, 2H), 2.46 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 211.9, 139.4, 137.0, 133.0, 112.4, 65.3, 54.2, 45.3, 44.5, 22.8; IR (Neat Film NaCl) 2924, 2851, 1703, 1560, 1450, 1042, 902 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{10}H_{16}ON$ $[M+H]^+$: 166.1226; found: 166.1228.



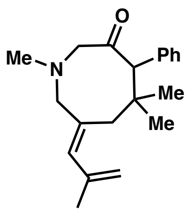
3g

3g (13.5 mg, 0.0700 mmol) was synthesized from **1g** (30.0 mg, 0.109 mmol); 64% yield; R_f = 0.35 (1:4 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.23 (ddd, J = 17.6, 11.0, 0.8 Hz, 1H), 5.85 (tq, J = 8.8, 0.8 Hz, 1H), 5.13 (d, J = 17.6 Hz, 1H), 4.95 (dd, J = 11.0, 0.8 Hz, 1H), 3.38 (s, 2H), 3.23 (s, 2H), 2.78 – 2.64 (m, 2H), 2.42 (s, 3H), 1.17 (s, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 214.2, 139.8, 137.4, 131.9, 112.0, 64.3, 55.4, 50.7, 45.4, 37.5, 24.9; IR (Neat Film NaCl) 2970, 2930, 1702, 1452, 1126, 891 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{12}H_{20}ON$ $[M+H]^+$: 194.1539; found: 194.1547.



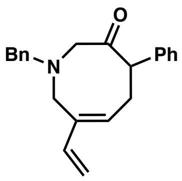
3h

3h (49.1 mg, 0.169 mmol) was synthesized from **1h** (102 mg, 0.242 mmol); 70% yield; R_f = 0.53 (1:4 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.14 (m, 10H), 6.12 – 6.03 (m, 1H), 3.94 – 3.78 (m, 3H), 3.34 (dd, J = 15.2, 1.3 Hz, 2H), 2.93 (d, J = 15.2 Hz, 1H), 2.63 – 2.51 (m, 1H), 2.37 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 210.1, 142.9, 139.3, 138.0, 128.7, 128.5, 128.2, 127.9, 127.3, 127.1, 126.2, 65.0, 60.8, 60.7, 45.9, 29.0; IR (Neat Film NaCl) 3058, 3029, 2900, 2928, 2825, 2801, 1956, 1882, 1806, 1698, 1597, 1490, 1442, 1276, 1260, 1124, 876, 761, 702 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{20}H_{22}NO$ $[M+H]^+$: 292.1623; found: 292.2742.



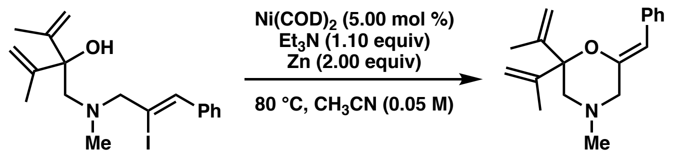
3i

3i (5.00 mg, 0.0169 mmol) was synthesized from **1i** (30.0 mg, 0.0705 mmol); 24% yield; R_f = 0.45 (1:8 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 – 7.47 (m, 2H), 7.23 (dd, *J* = 8.6, 7.0 Hz, 3H), 5.89 (s, 1H), 4.91 (d, *J* = 5.2 Hz, 2H), 4.65 (s, 1H), 3.44 (d, *J* = 12.7 Hz, 1H), 3.10 (dd, *J* = 15.4, 1.9 Hz, 1H), 3.02 (d, *J* = 13.1 Hz, 1H), 2.72 (d, *J* = 3.8 Hz, 1H), 2.68 (d, *J* = 6.5 Hz, 1H), 2.45 (s, 3H), 2.10 (d, *J* = 13.2 Hz, 1H), 1.81 (s, 3H), 1.04 (s, 3H), 0.74 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 212.3, 143.0, 138.1, 134.8, 134.5, 131.0, 127.6, 126.7, 114.6, 71.6, 70.7, 59.2, 46.5, 42.7, 41.3, 31.5, 23.1, 21.8; IR (Neat Film NaCl) 2943, 2796, 1709, 1450, 1357, 1127, 704 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{20}H_{28}ON$ $[M+H]^+$: 298.2165; found: 298.2168.



3j

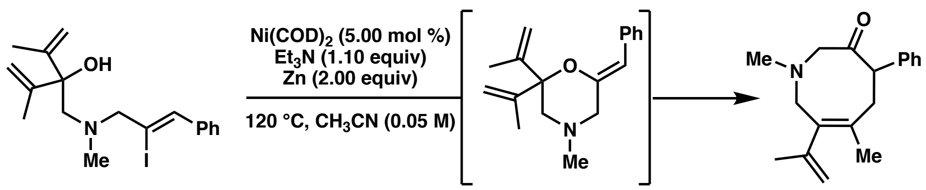
3j (22.0 mg, 0.0691 mmol) was synthesized from **1j** (41.6 mg, 0.0934 mmol); 74% yield; R_f = 0.35 (1:8 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.31 (m, 4H), 7.33 – 7.20 (m, 6H), 6.27 (dd, *J* = 17.6, 11.0 Hz, 1H), 5.97 (t, *J* = 8.4 Hz, 1H), 5.05 (d, *J* = 17.6 Hz, 1H), 4.96 (d, *J* = 11.0 Hz, 1H), 3.96 (td, *J* = 11.5, 8.8 Hz, 1H), 3.90 – 3.83 (m, 1H), 3.69 (d, *J* = 1.7 Hz, 2H), 3.59 (d, *J* = 15.2 Hz, 1H), 3.53 – 3.43 (m, 1H), 3.34 (d, *J* = 15.2 Hz, 1H), 2.97 (d, *J* = 15.2 Hz, 1H), 2.66 (ddd, *J* = 11.7, 8.2, 5.2 Hz, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 210.6, 139.5, 138.4, 138.3, 136.8, 131.4, 129.5, 128.8, 128.6, 127.9, 127.6, 127.4, 112.4, 63.9, 62.6, 60.1, 54.8, 29.3; IR (Neat Film NaCl) 2923, 1703, 1494, 1453, 901, 699 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{22}H_{24}ON$ $[M+H]^+$: 318.1852; found: 318.1858.



1k *2k*

Experiments were performed in a nitrogen-filled glove box. To a solution of aminoalcohol **1k** (50.0 mg, 0.126 mmol, 1.00 equiv) in MeCN (2.52 mL) in a scintillation vial were added Et_3N (19.3 μL, 0.139 mmol, 1.10 equiv), Zn powder (16.5 mg, 0.252 mmol, 2.00 equiv), and $Ni(COD)_2$ (0.00629 mmol, 0.05 equiv). The reaction mixture was stirred at 80 °C for 24 h. After the reaction was completed, the vial was removed from the glove box and uncapped. Solids were removed *via* filtration through a celite plug, and the resulting solution was concentrated under reduced pressure. The residue was purified by flash column chromatography to give morpholine **2k** (34.0 mg, 99% yield).

R_f = 0.25 (1:8 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 – 7.58 (m, 2H), 7.28 (dd, *J* = 8.5, 7.1 Hz, 3H), 7.20 – 7.09 (m, 1H), 5.47 (s, 1H), 5.04 (s, 2H), 5.01 (p, *J* = 1.4 Hz, 3H), 3.09 (s, 2H), 2.79 (s, 2H), 2.31 (s, 3H), 1.73 (dd, *J* = 1.5, 0.8 Hz, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 148.4, 144.1, 135.9, 128.7, 128.2, 125.8, 113.2, 107.5, 85.4, 59.5, 58.4, 46.5, 19.2; IR (Neat Film NaCl) 2971, 2767, 1663, 1645, 1448, 1361, 1345, 1249, 1179, 1141, 1078, 1060, 984, 903, 695 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{18}H_{24}ON$ $[M+H]^+$: 270.1852; found: 270.1862.

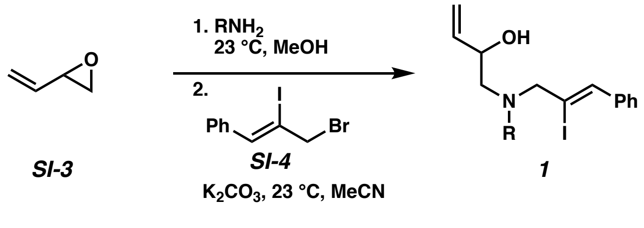


1k *2k* *3k*

Experiments were performed in a nitrogen-filled glove box. To a solution of aminoalcohol **1k** (20.0 mg, 0.0503 mmol, 1.00 equiv) in MeCN (1.00 mL) in a scintillation vial were added Et_3N (7.70 µL, 0.0553 mmol, 1.10 equiv), Zn powder (6.60 mg, 0.101 mmol, 2.00 equiv), and $Ni(COD)_2$ (0.70 mg, 0.00252 mmol, 0.05 equiv). The reaction mixture was stirred at 80 °C for 24 h. After the reaction was completed, the vial was removed from the glove box and uncapped. Solids were removed *via* filtration through a celite plug, and the resulting solution was concentrated under reduced pressure. The residue was purified by flash column chromatography to give hexahydroazocine **3k** (6.60 mg, 49% yield).

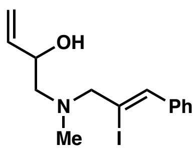
R_f = 0.27 (1:8 EtOAc:hexanes); ^1H NMR (500 MHz, $CDCl_3$) δ 7.53 – 7.46 (m, 2H), 7.39 – 7.31 (m, 2H), 7.33 – 7.25 (m, 1H), 4.91 (dq, *J* = 3.0, 1.6 Hz, 1H), 4.59 (dq, *J* = 1.9, 0.9 Hz, 1H), 4.22 (t, *J* = 12.2 Hz, 1H), 3.91 (dd, *J* = 12.4, 6.3 Hz, 1H), 3.68 – 3.59 (m, 1H), 3.26 (dd, *J* = 16.0, 0.9 Hz, 1H), 2.82 (dt, *J* = 16.0, 1.0 Hz, 1H), 2.75 (d, *J* = 14.8 Hz, 1H), 2.33 (s, 3H), 2.12 (dd, *J* = 12.0, 6.3 Hz, 1H), 1.76 (m, 6H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 210.0, 146.6, 138.2, 134.8, 132.1, 128.9, 128.2, 127.5, 113.3, 65.8, 61.7, 60.3, 46.1, 34.8, 22.0, 21.0; IR (Neat Film NaCl) 2913, 2794, 1701, 1450, 903, 768, 699 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{18}H_{24}ON$ $[M+H]^+$: 270.1852; found: 270.1871.

Representative procedure for secondary aminoalcohols



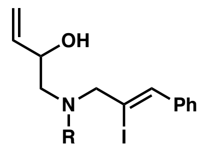
To epoxide **SI-3** (4.28 mmol, 1.00 equiv) was added RNH_2 (42.8 mmol, 10.0 equiv). The solution was stirred for 12 h at 23 °C. Volatiles were evaporated, and the residue was used without further purification.

To a solution of the amine (4.28 mmol, 1.00 equiv) in MeCN (11.0 mL) were added K_2CO_3 (21.4 mmol, 5.00 equiv) and allyl bromide **SI-4** (2.14 mmol, 0.50 equiv). The solution was stirred for 12 h at 23 °C. After the reaction was completed, water was added. The aqueous phase was extracted with EtOAc (3 x 7.00 mL). The combined organic phases were washed with brine, dried over anhydrous $MgSO_4$ and concentrated *in vacuo*. The residue was purified by flash column chromatography (1:4 EtOAc:hexanes) on silica gel to give secondary alcohols **1** in 14-36% 2-step yield based on equivalent of allyl bromide **SI-4**.



1l

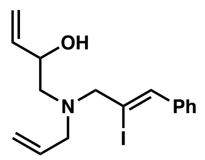
1l (515 mg, 1.50 mmol) was synthesized from 3,4-epoxy-1-butene (300 mg, 4.28 mmol); 35% yield (2 steps); R_f = 0.65 (1:2 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 – 7.55 (m, 2H), 7.43 – 7.34 (m, 3H), 7.10 – 6.98 (s, br, 1H), 5.84 (ddd, *J* = 17.2, 10.5, 5.8 Hz, 1H), 5.45 – 5.37 (m, 1H), 5.21 (dt, *J* = 10.5, 1.5 Hz, 1H), 4.29 (s, br, 1H), 3.54 (s, br, 1H), 3.41 (s, br, 1H), 2.58 (s, br, 2H), 2.40 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 138.0, 137.2, 136.9, 128.8, 128.4, 128.3, 116.3, 70.7, 68.7, 62.8, 61.1, 41.2; IR (Neat Film NaCl) 3435, 2795, 1491, 1446, 1083, 1029, 921, 750, 695 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{14}H_{19}NOI$ $[M+H]^+$: 344.0506; found: 344.0523.



R = *n*-hexyl

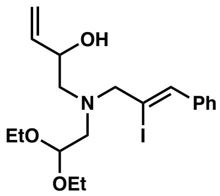
1n

1n (731 mg, 1.77 mmol) was synthesized from 3,4-epoxy-1-butene (452 mg, 6.45 mmol); 27% yield (2 steps); R_f = 0.69 (1:4 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.57 – 7.49 (m, 2H), 7.41 – 7.29 (m, 3H), 6.97 (s, 1H), 5.81 (ddd, *J* = 17.3, 10.5, 5.7 Hz, 1H), 5.36 (dt, *J* = 17.2, 1.6 Hz, 1H), 5.17 (dt, *J* = 10.5, 1.5 Hz, 1H), 4.27 – 4.13 (m, 1H), 3.72 (s, 1H), 3.59 (d, *J* = 13.9 Hz, 1H), 3.33 (d, *J* = 13.8 Hz, 1H), 2.64 (dt, *J* = 13.1, 7.9 Hz, 1H), 2.60 – 2.41 (m, 3H), 1.61 – 1.44 (m, 2H), 1.41 – 1.21 (m, 6H), 0.96 – 0.83 (m, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 138.2, 137.5, 136.3, 128.8, 128.28, 128.25, 116.1, 107.6, 68.8, 67.6, 59.7, 53.4, 31.8, 27.3, 26.6, 22.8, 14.2; IR (Neat Film NaCl) 3460, 2953, 2928, 2856, 1491, 1445, 1362, 1286, 1150, 1080, 992, 921, 860, 749, 695 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{19}H_{29}INO$ [M+H]$^+$: 414.1288; found: 414.1296.



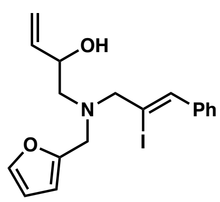
1o

1o (552 mg, 1.49 mmol) was synthesized from 3,4-epoxy-1-butene (452 mg, 6.45 mmol); 23% yield (2 steps); R_f = 0.61 (1:4 EtOAc:hexanes); ^{1}H NMR (300 MHz, $CDCl_3$) ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.58 – 7.49 (m, 2H), 7.42 – 7.28 (m, 3H), 6.98 (s, 1H), 5.99 – 5.85 (m, 1H), 5.86 – 5.70 (m, 1H), 5.42 – 5.09 (m, 4H), 4.33 – 4.16 (m, 1H), 3.76 – 3.55 (m, 2H), 3.35 (dd, *J* = 14.2, 4.7 Hz, 2H), 3.15 (dd, *J* = 14.3, 7.7 Hz, 1H), 2.57 (qd, *J* = 12.8, 6.8 Hz, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) 138.0, 137.2, 136.5, 134.0, 128.7, 128.2, 128.1, 118.8, 116.0, 107.0, 68.6, 66.6, 58.9, 55.8; IR (Neat Film NaCl): 3450, 3078, 2978, 2929, 2820, 1949, 1851, 1688, 1643, 1491, 1446, 1362, 1251, 1081, 993, 923, 751, 696 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{16}H_{21}INO$ $[M+H]^+$: 370.0662; found: 370.0664.



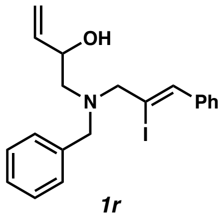
1p

1p (283 mg, 0.635 mmol) was synthesized from 3,4-epoxy-1-butene (409 mg, 5.84 mmol); 11% yield (2 steps); R_f = 0.38 (1:4 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.54 – 7.47 (m, 2H), 7.39 – 7.28 (m, 3H), 6.99 (s, 1H), 5.80 (ddd, *J* = 17.2, 10.5, 5.8 Hz, 1H), 5.34 (dt, *J* = 17.2, 1.6 Hz, 1H), 5.15 (dt, *J* = 10.5, 1.5 Hz, 1H), 4.65 (t, *J* = 5.4 Hz, 1H), 4.28 – 4.19 (m, 1H), 3.95 (s, 1H), 3.77 – 3.65 (m, 3H), 3.58 (dpd, *J* = 9.2, 7.0, 2.9 Hz, 3H), 2.90 – 2.70 (m, 3H), 2.59 (dd, *J* = 13.1, 10.2 Hz, 1H), 1.24 (td, *J* = 7.0, 1.0 Hz, 6H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 138.0, 137.3, 136.2, 128.7, 128.2, 128.1, 115.9, 107.0, 101.8, 69.7, 69.3, 62.9, 62.3, 61.2, 56.5, 15.5, 15.4; IR(Neat Film NaCl) 3457, 2975, 2879, 1686, 1646, 1491, 1445, 1374, 1255, 1122, 1063, 921, 859, 750, 696 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{19}H_{29}INO_3$ $[M+H]^+$: 446.1187; found: 446.1185.



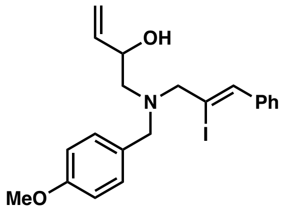
1q

1q (306 mg, 0.748 mmol) was synthesized from 3,4-epoxy-1-butene (452 mg, 6.45 mmol); 12% (2 steps); R_f = 0.59 (1:4 EtOAc:hexanes) ; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.59 – 7.52 (m, 2H), 7.44 – 7.29 (m, 4H), 7.04 (s, 1H), 6.35 (dd, J = 3.2, 1.9 Hz, 1H), 6.23 (dd, J = 3.2, 0.8 Hz, 1H), 5.81 (ddd, J = 17.2, 10.5, 5.7 Hz, 1H), 5.36 (dt, J = 17.2, 1.6 Hz, 1H), 5.17 (dt, J = 10.5, 1.5 Hz, 1H), 4.24 (dddd, J = 10.3, 5.7, 3.1, 1.5 Hz, 1H), 3.86 – 3.76 (m, 2H), 3.70 (s, 1H), 3.60 (dd, J = 13.9, 1.4 Hz, 1H), 3.42 (dd, J = 13.8, 1.1 Hz, 1H), 2.72 (dd, J = 13.0, 3.2 Hz, 1H), 2.55 (dd, J = 13.0, 10.3 Hz, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 151.5, 142.5, 138.1, 137.3, 137.0, 128.8, 128.4, 128.3, 116.2, 110.3, 109.4, 106.9, 68.9, 66.5, 59.3, 48.4; IR (Neat Film NaCl) 3458, 3080, 2932, 2831, 1951, 1754, 1645, 1598, 1501, 1445, 1364, 1318, 1285, 1250, 1148, 1074, 1012, 921, 750, 696 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{18}H_{21}INO_2$ [M+H]$^+$: 410.0611; found: 410.0615.



1r

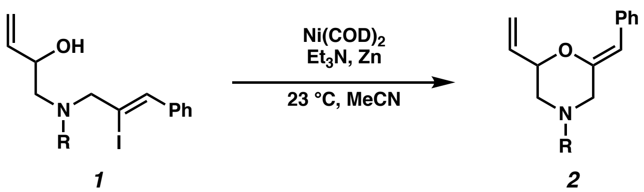
1r (334 mg, 0.797 mmol) was synthesized from 3,4-epoxy-1-butene (452 mg, 6.45 mmol); 12% yield (2 steps); R_f = 0.43 (1:4 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 – 7.50 (m, 2H), 7.41 – 7.27 (m, 8H), 7.01 (s, 1H), 5.76 (ddd, J = 17.2, 10.5, 5.8 Hz, 1H), 5.32 (dt, J = 17.2, 1.5 Hz, 1H), 5.14 (dt, J = 10.5, 1.4 Hz, 1H), 4.22 (tdd, J = 7.3, 5.4, 1.4 Hz, 1H), 3.93 (d, J = 13.5 Hz, 1H), 3.66 (dd, J = 13.8, 1.4 Hz, 1H), 3.55 (d, J = 13.6 Hz, 2H), 3.36 (dd, J = 13.7, 0.9 Hz, 1H), 2.62 – 2.54 (m, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 138.1, 137.7, 137.4, 137.1, 129.6, 128.8, 128.6, 128.34, 128.25, 127.6, 116.2, 107.0, 68.9, 67.1, 59.3, 57.9; IR (Neat Film NaCl) 3460, 3082, 3060, 3025, 2935, 2813, 1950, 1880, 1808, 1710, 1645, 1600, 1493, 1446, 1364, 1245, 1125, 1076, 991, 921, 744, 697 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{20}H_{23}INO$ $[M+H]^+$: 420.0819; found: 420.0836.



1s

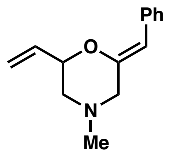
1s (158 mg, 0.351 mmol) was synthesized from 3,4-epoxy-1-butene (452 mg, 6.45 mmol); 5% (2 steps); R_f = 0.45 (1:4 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 – 7.47 (m, 2H), 7.39 – 7.27 (m, 5H), 7.00 (s, 1H), 6.91 – 6.85 (m, 2H), 5.75 (ddd, *J* = 17.3, 10.5, 5.8 Hz, 1H), 5.31 (dt, *J* = 17.2, 1.5 Hz, 1H), 5.13 (dt, *J* = 10.5, 1.4 Hz, 1H), 4.24 – 4.15 (m, 1H), 3.86 (d, *J* = 13.4 Hz, 1H), 3.81 (s, 3H), 3.63 (d, *J* = 13.7 Hz, 1H), 3.55 (s, 1H), 3.49 (d, *J* = 13.4 Hz, 1H), 3.32 (d, *J* = 13.8 Hz, 1H), 2.63 – 2.50 (m, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 158.9, 138.0, 137.2, 136.8, 130.6, 129.5, 128.7, 128.2, 128.1, 116.0, 113.8, 107.0, 68.7, 66.8, 59.0, 57.1, 55.2; IR (Neat Film NaCl) 3448, 2933, 2833, 1611, 1511, 1444, 1302, 1249, 1174, 1081, 1034, 922, 845, 750, 696 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{21}H_{25}INO_2$ $[M+H]^+$: 450.0924; found: 450.0914.

Representative procedure for morpholines



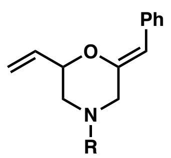
Ni-Catalyzed C–O bond formation experiments were performed in a nitrogen-filled glove box. To a solution of aminoalcohol **1** (0.291 mmol, 1.00 equiv) in MeCN (1.94

mL) in a scintillation vial were added Et_3N (0.320 mmol, 1.10 equiv), Zn powder (0.582 mmol, 2.00 equiv), and $Ni(COD)_2$ (0.0146 mmol, 0.05 equiv). The mixture was stirred at 23 °C for 24 h. After the reaction was completed, the vial was removed from the glovebox and uncapped. Solids were removed *via* filtration through a celite plug, and the resulting solution was concentrated under reduced pressure. The residue was purified by flash column chromatography using a mixture of hexanes and ethyl acetate as eluent to furnish morpholine **2**.



2l

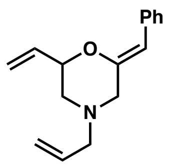
2l (149 mg, 0.692 mmol) was synthesized from **1l** (379 mg, 1.10 mmol); 63% yield; R_f = 0.23 (1:2 EtOAc:hexanes); ^{1}H NMR (400 MHz, CD_2Cl_2) δ 7.51 (dd, J = 8.3, 1.4 Hz, 2H), 7.18 (dd, J = 8.4, 7.0 Hz, 2H), 7.08 – 7.01 (m, 1H), 5.89 (ddd, J = 17.3, 10.7, 5.6 Hz, 1H), 5.40 – 5.32 (m, 2H), 5.19 – 5.16 (m, 1H), 4.35 (dddt, J = 9.8, 5.7, 2.9, 1.5 Hz, 1H), 3.09 (dd, J = 12.6, 1.6 Hz, 1H), 2.78 – 2.69 (m, 2H), 2.21 (s, 3H), 2.08 (dd, J = 11.7, 9.5 Hz, 1H); ^{13}C NMR (101 MHz, CD_2Cl_2) δ 150.5, 136.4, 136.2, 128.9, 128.6, 126.4, 117.1, 107.9, 78.0, 59.5, 58.3, 46.2; IR (Neat Film NaCl) 2939, 2784, 2360, 1666, 1448, 1328, 1239, 1176, 1133, 1047, 985, 937, 755, 694 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{14}H_{18}NO$ $[M+H]^+$: 216.1383; found: 216.1399.



R = *n*-hexyl

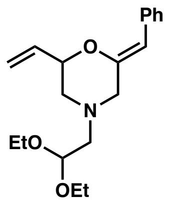
2n

2n (262 mg, 0.918 mmol) was synthesized from **1n** (436 mg, 1.05 mmol); 87% yield; R_f = 0.32 (1:4 EtOAc:hexanes); ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.63 – 7.57 (m, 2H), 7.27 (dd, *J* = 8.4, 7.1 Hz, 2H), 7.17 – 7.10 (m, 1H), 5.95 (ddd, *J* = 17.3, 10.7, 5.5 Hz, 1H), 5.50 (d, *J* = 1.3 Hz, 1H), 5.46 (dt, *J* = 17.3, 1.5 Hz, 1H), 5.27 (dt, *J* = 10.7, 1.4 Hz, 1H), 4.46 (dddt, *J* = 9.8, 5.6, 2.9, 1.5 Hz, 1H), 3.30 (dd, *J* = 12.6, 1.6 Hz, 1H), 2.95 – 2.83 (m, 2H), 2.42 – 2.33 (m, 2H), 2.20 (dd, *J* = 11.8, 9.8 Hz, 1H), 1.58 – 1.46 (m, 2H), 1.38 – 1.23 (m, 6H), 0.94 – 0.85 (m, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 149.5, 135.7, 135.5, 128.4, 128.1, 125.9, 116.9, 108.2, 77.1, 58.5, 57.2, 56.2, 31.7, 27.1, 26.5, 22.6, 14.0; IR (Neat Film NaCl): 3087, 3022, 2930, 2858, 2806, 1945, 1875, 1741, 1667, 1598, 1449, 1373, 1326, 1178, 1116, 987, 939, 826, 754, 694 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{19}H_{28}NO$ [M+H]$^+$: 286.2165; found: 286.2165.



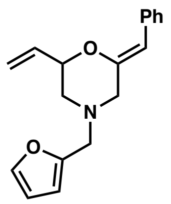
2o

2o (161 mg, 0.667 mmol) was synthesized from **1o** (289 mg, 0.783 mmol); 85% yield; R_f = 0.31 (1:4 EtOAc:hexanes); ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.65 – 7.57 (m, 2H), 7.33 – 7.24 (m, 2H), 7.19 – 7.11 (m, 1H), 6.03 – 5.80 (m, 2H), 5.53 – 5.41 (m, 2H), 5.31 – 5.18 (m, 3H), 4.51 – 4.41 (m, 1H), 3.29 (dd, *J* = 12.6, 1.7 Hz, 1H), 3.05 (dt, *J* = 6.5, 1.3 Hz, 2H), 2.97 – 2.84 (m, 2H), 2.21 (dd, *J* = 11.8, 9.7 Hz, 1H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 149.3, 135.6, 135.4, 134.1, 128.4, 128.1, 125.9, 118.8, 116.9, 108.3, 77.2, 61.4, 56.9, 56.0; IR (Neat Film NaCl): 3083, 3022, 2905, 2794, 1947, 1874, 1742, 1668, 1598, 1494, 1325, 1178, 1047, 994, 928, 827, 756, 695 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{16}H_{20}NO$ [M+H]$^+$: 242.1539; found: 242.1543.



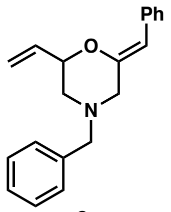
2p

2p (128 mg, 0.403 mmol) was synthesized from **1p** (307 mg, 0.689 mmol); 58% yield; R_f = 0.61 (1:4 EtOAc:hexanes); ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.65 – 7.55 (m, 2H), 7.34 – 7.21 (m, 2H), 7.19 – 7.07 (m, 1H), 5.94 (ddd, *J* = 17.3, 10.7, 5.5 Hz, 1H), 5.52 – 5.38 (m, 2H), 5.26 (dt, *J* = 10.7, 1.4 Hz, 1H), 4.68 (t, *J* = 5.3 Hz, 1H), 4.46 (dddt, *J* = 9.8, 5.7, 2.9, 1.4 Hz, 1H), 3.76 – 3.51 (m, 4H), 3.37 (dd, *J* = 12.7, 1.6 Hz, 1H), 3.08 – 2.94 (m, 2H), 2.68 – 2.50 (m, 2H), 2.38 (dd, *J* = 11.9, 9.7 Hz, 1H), 1.23 (td, *J* = 7.1, 3.6 Hz, 6H); ^{13}C NMR (75 MHz, $CDCl_3$) δ (ppm) 149.5, 135.6, 135.4, 128.4, 128.0, 125.8, 116.8, 107.9, 101.4, 77.0, 62.0, 61.9, 60.3, 57.8, 56.6, 15.3; IR (Neat Film NaCl) 2975, 2928, 1741, 1667, 1598, 1494, 1449, 1374, 1322, 1121, 1063, 943, 847, 756, 695 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{19}H_{28}NO_3$ $[M+H]^+$: 318.2064; found: 318.2066.



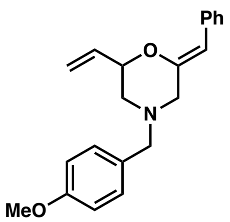
2q

2q (187 mg, 0.665 mmol) was synthesized from **1q** (298 mg, 0.728 mmol); 91% yield (2 steps); R_f = 0.52 (1:4 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 – 7.57 (m, 2H), 7.42 (dd, *J* = 1.9, 0.8 Hz, 1H), 7.30 – 7.25 (m, 2H), 7.17 – 7.12 (m, 1H), 6.36 (dd, *J* = 3.2, 1.8 Hz, 1H), 6.27 (dd, *J* = 3.2, 0.8 Hz, 1H), 5.93 (ddd, *J* = 17.3, 10.7, 5.5 Hz, 1H), 5.49 – 5.43 (m, 2H), 5.27 (dt, *J* = 10.7, 1.4 Hz, 1H), 4.50 – 4.45 (m, 1H), 3.62 (s, 2H), 3.30 (dd, *J* = 12.6, 1.7 Hz, 1H), 3.00 – 2.89 (m, 2H), 2.28 (dd, *J* = 11.7, 9.9 Hz, 1H); [13]C NMR (126 MHz, $CDCl_3$) δ 150.5, 149.1, 142.5, 135.6, 135.2, 128.4, 128.1, 125.9, 117.0, 110.2, 109.3, 108.5, 77.0, 56.6, 55.5, 54.4; IR (Neat Film NaCl) 3086, 2935, 2809, 1950, 1880, 1737, 1666, 1598, 1494, 1450, 1326, 1178, 1148, 1040, 1013, 991, 934, 820, 756, 738, 695 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{18}H_{20}NO_2$: 282.1488; found: 282.1494.



2r

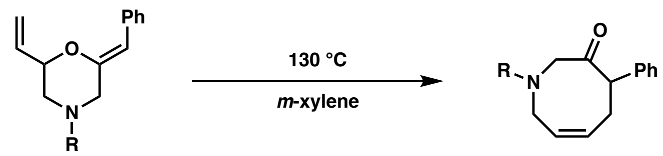
2r (136 mg, 0.467 mmol) was synthesized from **1r** (247 mg, 0.589 mmol); 79% yield; R_f = 0.50 (1:4 EtOAc:hexanes); [1]H NMR (300 MHz, $CDCl_3$) δ 7.64 – 7.54 (m, 2H), 7.40 – 7.20 (m, 7H), 7.18 – 7.07 (m, 1H), 5.93 (ddd, *J* = 17.1, 10.6, 5.5 Hz, 1H), 5.49 – 5.37 (m, 2H), 5.24 (dt, *J* = 10.7, 1.4 Hz, 1H), 4.46 (dddt, *J* = 9.7, 5.6, 2.9, 1.4 Hz, 1H), 3.55 (s, 2H), 3.25 (dd, *J* = 12.6, 1.6 Hz, 1H), 2.98 – 2.81 (m, 2H), 2.23 (dd, *J* = 11.7, 9.6 Hz, 1H); [13]C NMR (126 MHz, $CDCl_3$) δ (ppm) 149.5, 137.2, 135.7, 135.4, 129.1, 128.4, 128.4, 128.1, 127.4, 125.9, 116.9, 108.0, 77.1, 62.7, 56.9, 56.1; IR (Neat Film NaCl) 3085, 3024, 2943, 2875, 2805, 2757, 1954, 1881, 1812, 1744, 1666, 1598, 1493, 1451, 1322, 1239, 1177, 1111, 1043, 826, 991, 933, 755, 696 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{20}H_{22}NO$ $[M+H]^+$: 292.1696; found: 292.1703.



2s

2s (128 mg, 0.398 mmol) was synthesized from **1s** (236 mg, 0.525 mmol); 76% yield; R_f = 0.52 (1:4 EtOAc:hexanes) = 0.52; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.69 – 7.63 (m, 2H), 7.33 (ddd, *J* = 9.5, 4.4, 2.0 Hz, 4H), 7.20 (td, *J* = 7.3, 1.3 Hz, 1H), 6.98 – 6.92 (m, 2H), 6.04 – 5.94 (m, 1H), 5.54 – 5.46 (m, 2H), 5.31 (dt, *J* = 10.7, 1.4 Hz, 1H), 4.52 (dddt, *J* = 9.7, 5.7, 2.9, 1.4 Hz, 1H), 3.88 (d, *J* = 1.2 Hz, 3H), 3.56 (d, *J* = 1.6 Hz, 2H), 3.32 (dd, *J* = 12.7, 1.6 Hz, 1H), 2.98 (dd, *J* = 12.6, 1.4 Hz, 1H), 2.93 (ddd, *J* = 11.7, 2.9, 1.6 Hz, 1H), 2.32 – 2.22 (m, 1H);^{13}C NMR (126 MHz, $CDCl_3$) δ 158.9, 149.5, 135.7, 135.4, 130.3, 129.1, 128.4, 128.1, 125.8, 116.8, 113.7, 108.0, 77.1, 62.1, 56.8, 56.0, 55.2; IR (Neat Film NaCl) 3056, 3020, 2933, 2834, 2801, 1738, 1666, 1612, 1512, 1454, 1324, 1289, 1249, 1177, 1106, 1036, 992, 938, 830, 756, 696 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{21}H_{24}NO_2$ [M+H]$^+$: 322.1802, Found: 322.1797.

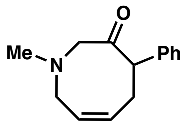
Representative procedure for Claisen rearrangement



2 *3*

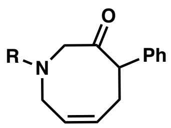
A half dram vial, equipped with a stir bar, was charged with morpholine **2** (0.0929 mmol) and *m*-xylene (860 μL) in a nitrogen-filled glove box. The vial was heated at 130 °C using a heating block for 12 h. After cooling to 23 °C, the mixture was purified using silica gel chromatography with a mixture of hexanes and ethyl acetate as eluent to afford Claisen rearrangement product **3**.

Note: Due to the COVID-19 pandemic, we are unable to conduct this experiment on a 1 mmol scale due to limitations in our experimental lab in terms of capacity and personnel.



3l

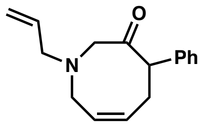
3l (15.3 mg, 0.0711 mmol) was synthesized from **2l** (20.0 mg, 0.0929 mmol); Note: the reaction was setup at 135 °C for 12 h; 77% yield; R_f = 0.39 (1:2 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.46 – 7.41 (m, 2H), 7.35 (ddd, *J* = 7.7, 6.8, 1.2 Hz, 2H), 7.31 – 7.26 (m, 1H), 5.94 (m, 1H), 5.61 (dt, *J* = 10.8, 5.1 Hz, 1H), 3.87 (d, *J* = 13.8 Hz, 2H), 3.55 (d, *J* = 15.8 Hz, 1H), 3.42 (d, *J* = 15.3 Hz, 1H), 3.02 (t, *J* = 15.3 Hz, 1H), 2.84 (d, *J* = 15.4 Hz, 1H), 2.48 – 2.43 (m, 1H), 2.40 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 210.7, 138.3, 130.9, 129.0, 128.7, 128.1, 127.6, 66.1, 61.3, 58.1, 45.9, 29.1; IR (Neat Film NaCl) 2928, 2791, 1696, 1493, 1451, 1268, 1126, 699 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{14}H_{18}NO$ $[M+H]^+$: 216.1383; found: 216.1398.



R = *n*-hexyl

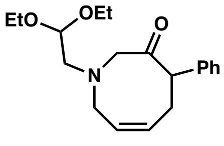
3n

3n (18.2 mg, 0.0638 mmol) was synthesized from **2n** (23.8 mg, 0.0834 mmol); 76% yield; R_f = 0.43 (1:4 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.14 (m, 5H), 5.83 (dtd, *J* = 11.0, 8.5, 8.0, 2.0 Hz, 1H), 5.56 – 5.46 (m, 1H), 3.93 – 3.76 (m, 2H), 3.49 (dt, *J* = 16.2, 3.0 Hz, 1H), 3.37 (d, *J* = 15.3 Hz, 1H), 2.95 (dd, *J* = 16.0, 5.4 Hz, 1H), 2.80 (d, *J* = 15.3 Hz, 1H), 2.38 (td, *J* = 7.7, 6.9, 5.3 Hz, 3H), 1.48 – 1.32 (m, 2H), 1.32 – 1.15 (m, 6H), 0.82 (t, *J* = 6.8 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 211.1, 138.1, 130.2, 128.6, 128.1, 127.8, 127.3, 64.4, 60.5, 57.4, 55.6, 31.7, 28.6, 27.1, 27.0, 22.6, 14.0; IR (Neat Film NaCl): 3023, 1703, 1494, 1454, 1376, 1262, 1163, 1031, 768, 723, 700 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{19}H_{28}NO$ [M+H]$^+$: 286.2165; found: 286.2191.



3o

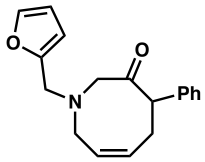
3o (15.2 mg, 0.0630 mmol) was synthesized from **2o** (26.7 mg, 0.111 mmol); 57% yield; R_f = 0.38 (1:4 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.43 – 7.38 (m, 2H), 7.34 (dd, *J* = 8.4, 6.8 Hz, 2H), 7.31 – 7.25 (m, 1H), 5.96 – 5.80 (m, 2H), 5.58 (dt, *J* = 10.4, 4.9 Hz, 1H), 5.23 – 5.12 (m, 2H), 4.00 – 3.91 (m, 1H), 3.91 – 3.85 (m, 1H), 3.57 (dt, *J* = 16.0, 3.3 Hz, 1H), 3.46 (d, *J* = 15.5 Hz, 1H), 3.10 (t, *J* = 5.0 Hz, 2H), 3.02 (dd, *J* = 16.0, 5.4 Hz, 1H), 2.86 (d, *J* = 15.4 Hz, 1H), 2.47 (ddd, *J* = 11.4, 7.8, 5.4 Hz, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 211.1, 138.1, 134.8, 130.2, 128.7, 128.5, 128.1, 127.8, 127.3, 118.6, 63.9, 60.5, 55.6, 28.7; IR (Neat Film NaCl) 3023, 2919, 2804, 1701, 1493, 1450, 1327, 1265, 1164, 993, 769, 700 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{16}H_{20}NO$ [M+H]$^+$: 242.1539; found: 242.1537.



3p

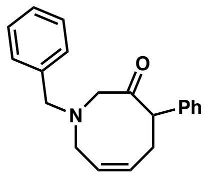
3p (8.80 mg, 0.0280 mmol) was synthesized from **2p** (24.8 mg, 0.0781 mmol); 35% yield; R_f = 0.50 (1:4 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 (dd, *J* = 7.5, 1.6 Hz, 2H), 7.34 (dd, *J* = 8.4, 6.8 Hz, 2H), 7.30 – 7.23 (m, 1H), 5.94 – 5.85 (m, 1H), 5.56 (m, 1H), 4.62 (t, *J* = 5.2 Hz, 1H), 3.98 (td, *J* = 11.7, 9.0 Hz, 1H), 3.90 (dd, *J* = 11.6, 5.8 Hz, 1H), 3.73 – 3.42 (m, 6H), 3.20 (dd, *J* = 16.2, 5.2 Hz, 1H), 3.03 (d, *J* = 15.6 Hz, 1H), 2.75 – 2.63 (m, 2H), 2.49 (ddd, *J* = 11.8, 7.7, 5.9 Hz, 1H), 1.22 (dt, *J* = 15.3, 7.1

Hz, 6H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 211.5, 138.3, 130.1, 128.7, 128.2, 127.9, 127.3, 101.2, 65.2, 62.2, 61.8, 60.4, 59.7, 56.5, 28.7, 15.4, 15.4; IR (Neat Film NaCl) 3023, 2974, 2927, 1702, 1599, 1452, 1374, 1269, 1124, 1064, 769, 700 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{19}H_{28}NO_3$ [M+H]$^+$: 318.2064; found: 318.2093.



3q

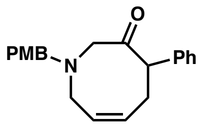
3q (12.2 mg, 0.0434 mmol) was synthesized from **2q** (23.5 mg, 0.0835 mmol); 52% yield; R_f = 0.45 (1:4 EtOAc:hexanes); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.28 (m, 3H), 7.26 – 7.21 (m, 2H), 7.20 – 7.14 (m, 1H), 6.25 (dd, *J* = 3.2, 1.9 Hz, 1H), 6.18 – 6.12 (m, 1H), 5.89 – 5.77 (m, 1H), 5.50 (m, 1H), 4.00 – 3.87 (m, 1H), 3.79 (dd, *J* = 12.0, 5.9 Hz, 1H), 3.62 – 3.44 (m, 4H), 3.00 (dd, *J* = 16.0, 5.4 Hz, 1H), 2.82 (d, *J* = 15.6 Hz, 1H), 2.35 (ddd, *J* = 12.0, 7.7, 5.9 Hz, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 210.9, 151.5, 142.4, 138.1, 130.4, 128.7, 127.9, 127.8, 127.3, 110.1, 109.3, 63.6, 60.9, 55.6, 53.7, 28.9; IR (Neat Film NaCl) 3024, 2924, 2809, 1698, 1494, 1450, 1336, 1241, 1147, 1012, 947, 916, 737, 700 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{18}H_{20}NO_2$ [M+H]$^+$: 282.1489; found: 282.1496.



3r

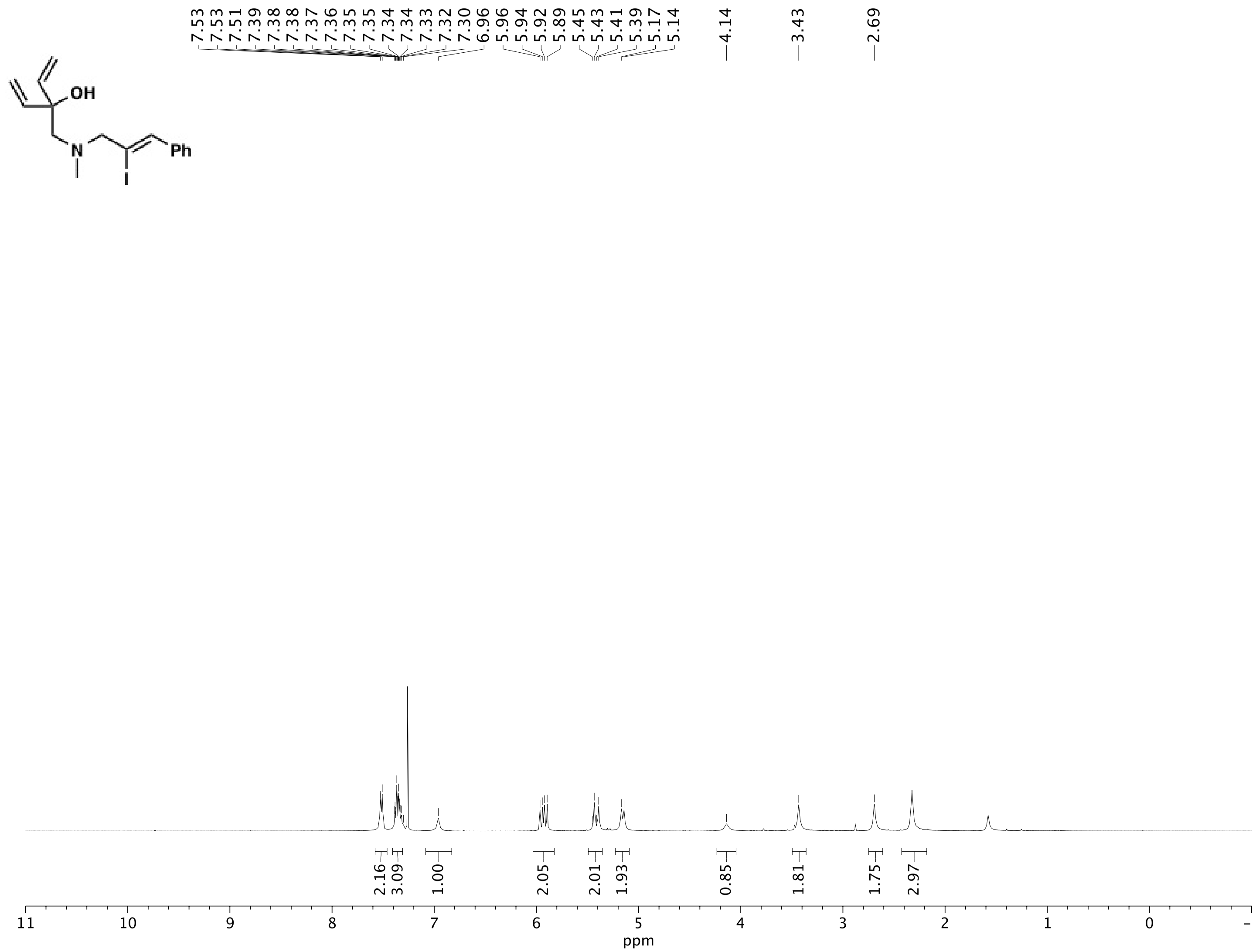
3r (15.2 mg, 0.0522 mmol) was synthesized from **2r** (24.9 mg, 0.0854 mmol); 61% yield; R_f = 0.34 (1:4 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.40 – 7.20 (m, 10H), 5.90 (m, 1H), 5.56 (m, 1H), 4.08 – 3.97 (m, 1H), 3.89 (dd, *J* = 11.7, 6.0 Hz, 1H), 3.66 – 3.50 (m, 4H), 3.04 (dd, *J* = 16.0, 5.4 Hz, 1H), 2.89 (d, *J* = 14.9 Hz, 1H), 2.53

(ddd, J = 12.2, 7.7, 6.0 Hz, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 210.9, 138.3, 137.9, 129.8, 129.3, 128.7, 128.4, 128.2, 127.7, 127.4, 127.2, 64.5, 62.1, 60.5, 56.2, 28.9; IR (Neat Film NaCl) 3060, 3026, 2922, 2806, 1699, 1953, 1880, 1494, 1453, 1310, 1161, 1109, 949, 733, 699 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{20}H_{22}NO$ $[M+H]^+$: 292.1696; found: 292.1721.

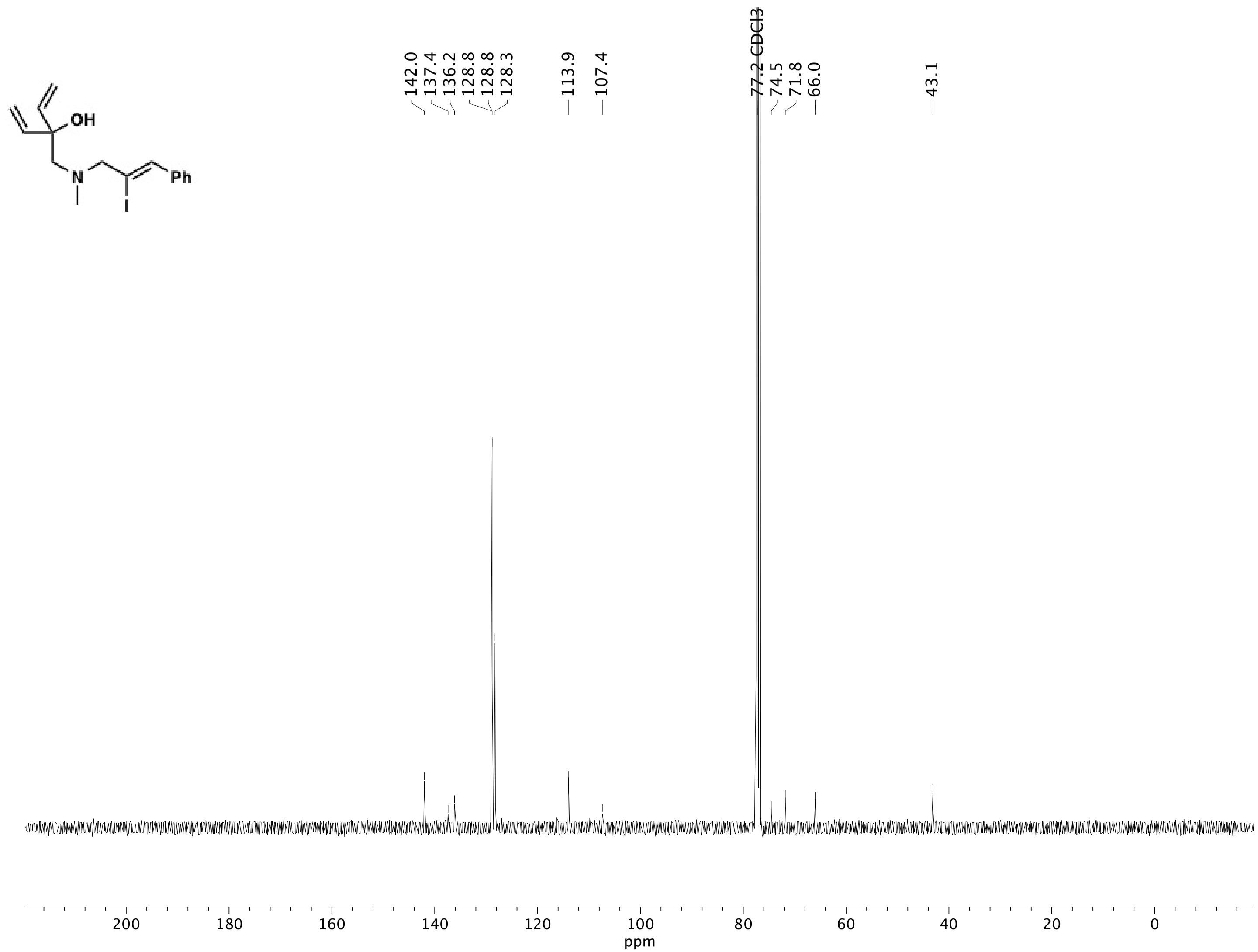


3s

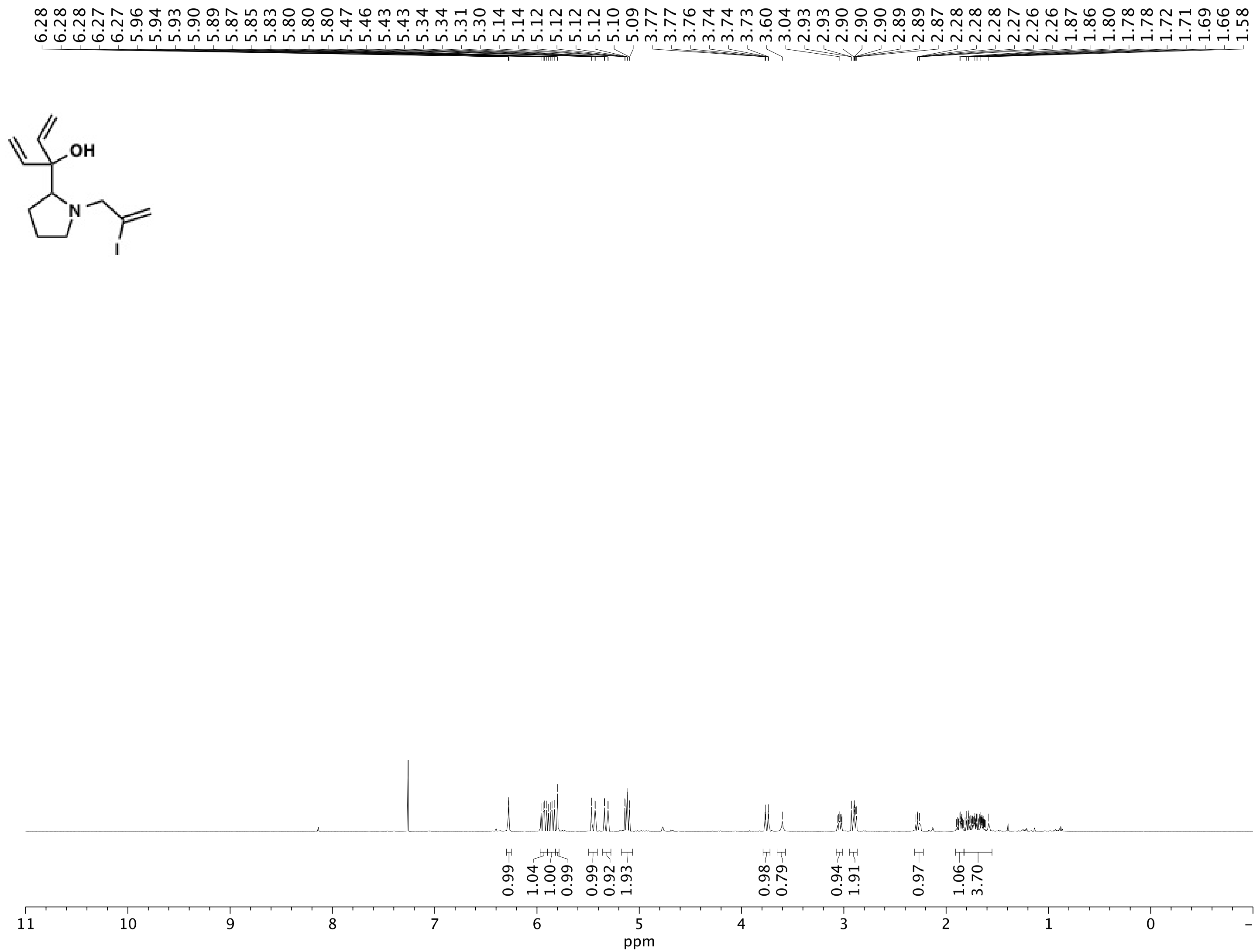
3s (20.0 mg, 0.0622 mmol) was synthesized from **2s** (25.1 mg, 0.0781 mmol); 80% yield; R_f = 0.32 (1:4 EtOAc:hexanes); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37 – 7.23 (m, 7H), 6.93 – 6.87 (m, 2H), 5.92 (m, 1H), 5.59 (m, 1H), 4.04 (td, J = 12.0, 8.9 Hz, 1H), 3.93 –3.88 (m, 1H), 3.85 (s, 3H), 3.64 – 3.51 (m, 4H), 3.05 (dd, J = 16.3, 5.3 Hz, 1H), 2.59 – 2.50 (m, 1H), 2.58 – 2.52 (m, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 211.1, 158.9, 138.3, 130.5, 130.0, 129.6, 128.6, 128.3, 127.7, 127.2, 113.7, 64.4, 61.5, 60.5, 56.2, 55.3, 28.9; IR (Neat Film NaCl) 3023, 2931, 2835, 2807, 1699, 1611, 1512, 1453, 1302, 1247, 1174, 1104, 1034, 832, 760, 700 cm^{-1}; HRMS (MM: ESI-APCI+) m/z calc'd for $C_{21}H_{24}NO_2$ $[M+H]^+$: 322.1802; found: 322.1828.



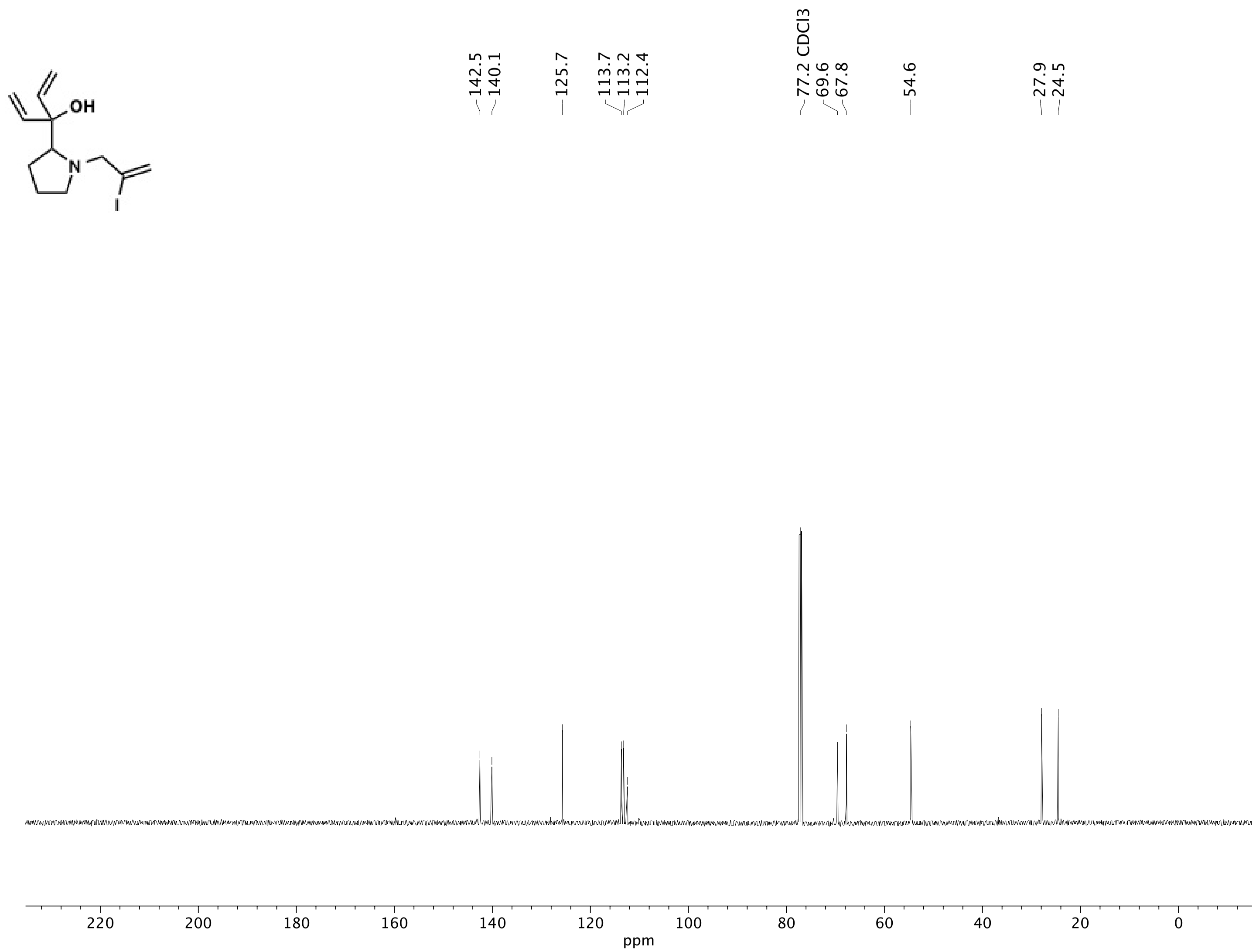
[1]H NMR (400 MHz, $CDCl_3$) of compound **1b**.



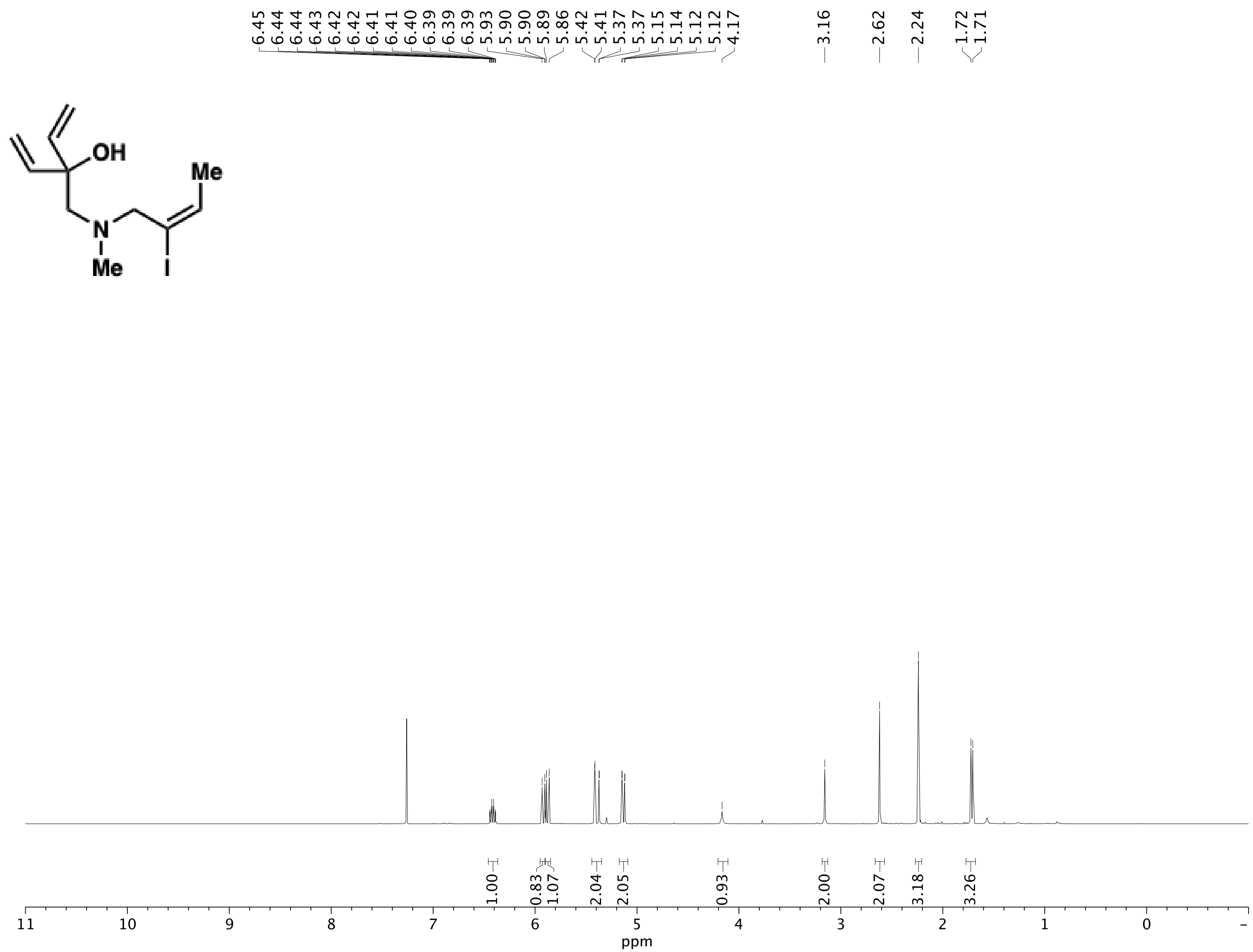
^{13}C NMR (101 MHz, $CDCl_3$) of compound **1b**.



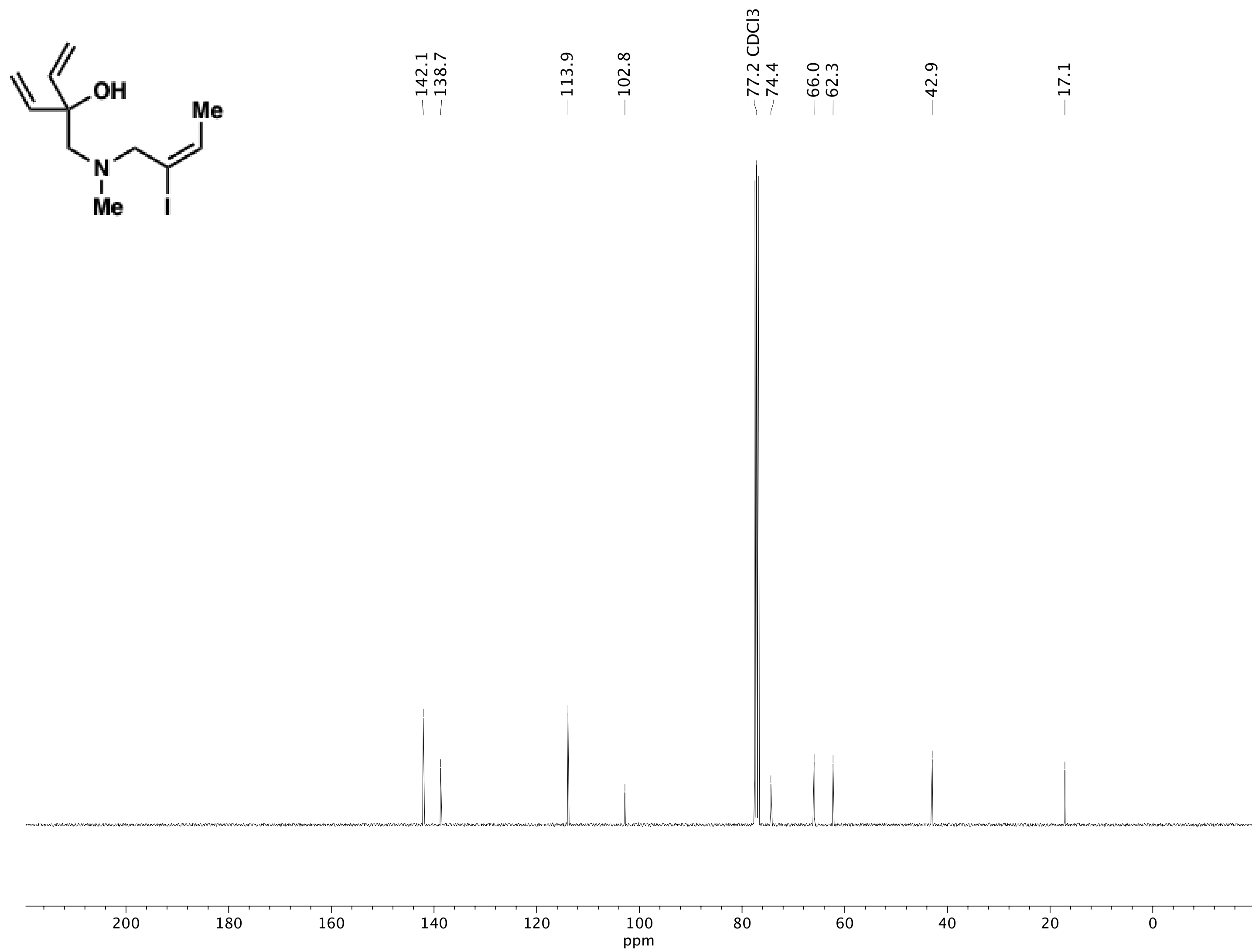
^{1}H NMR (400 MHz, $CDCl_3$) of compound **1c**.



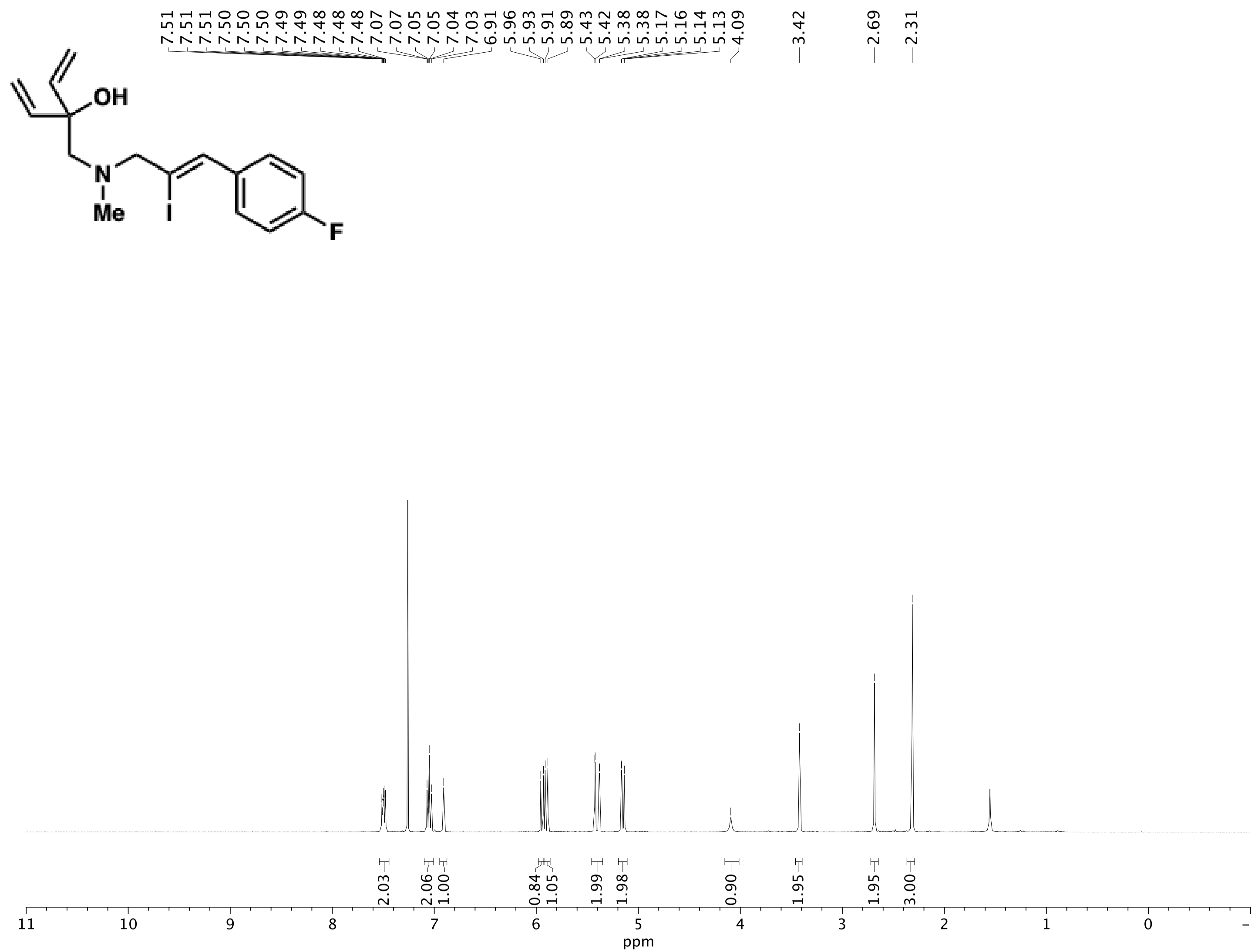
^{13}C NMR (126 MHz, $CDCl_3$) of compound **1c**.



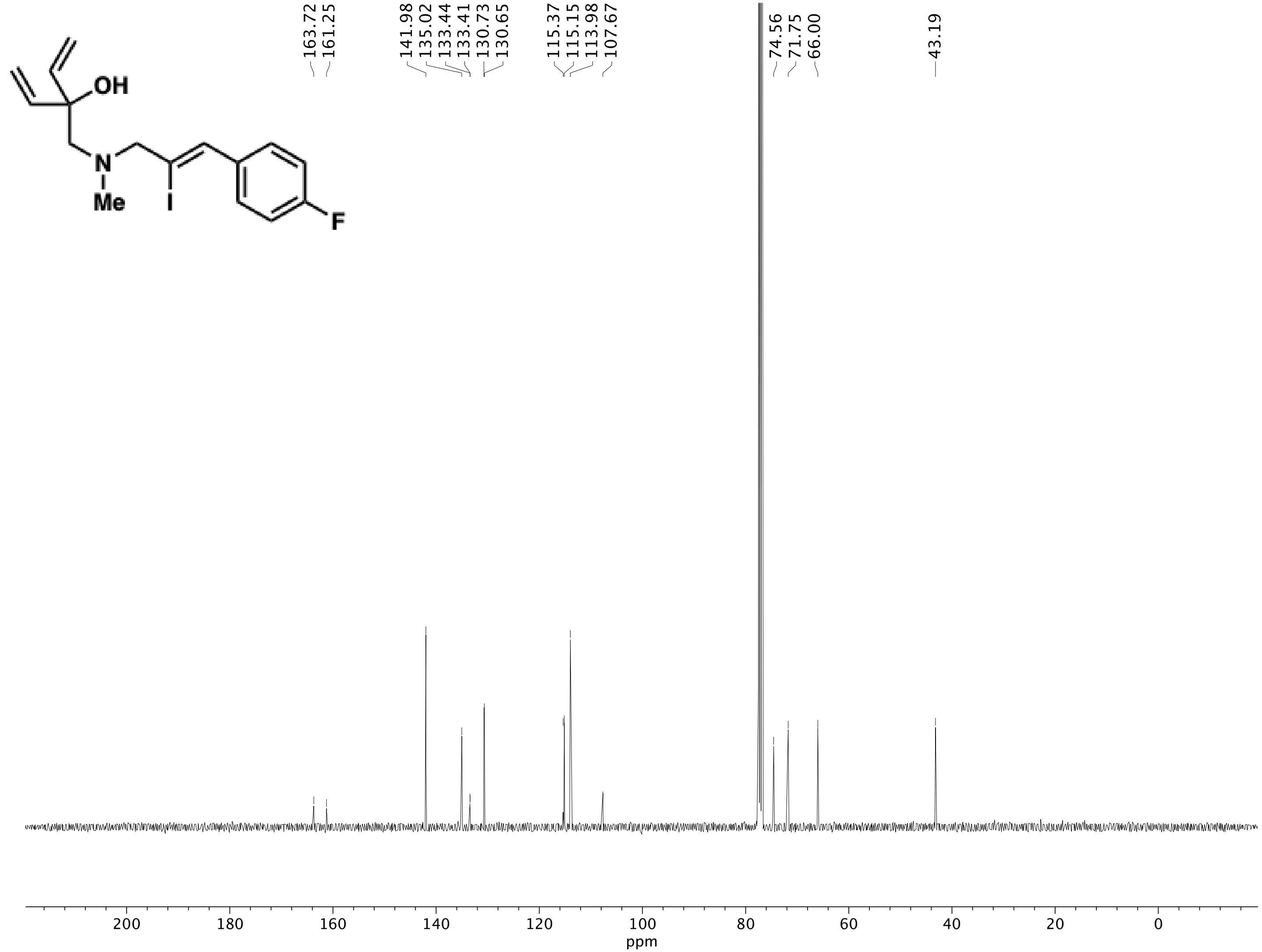
^{1}H NMR (400 MHz, $CDCl_3$) of compound **1d**.



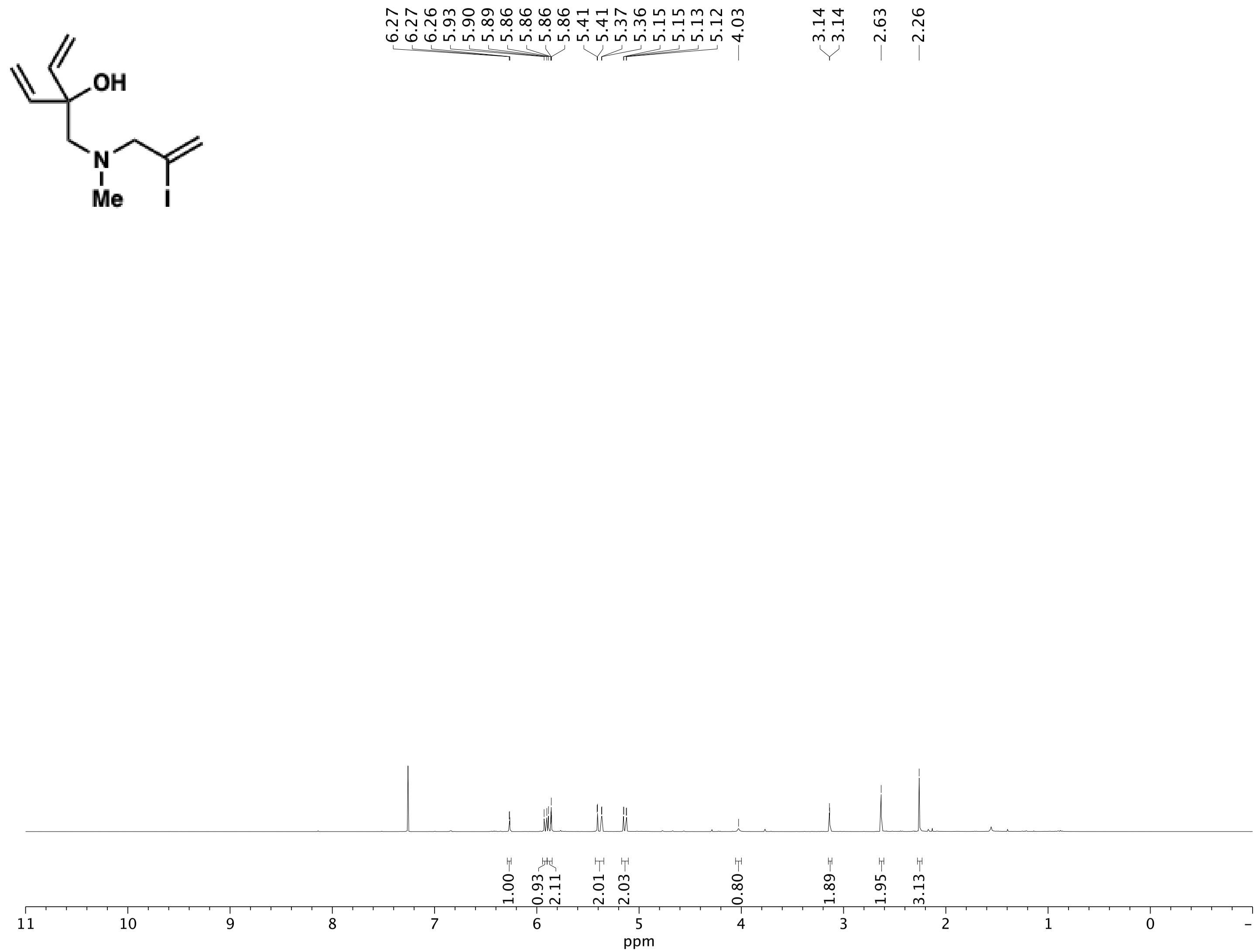
^{13}C NMR (101 MHz, $CDCl_3$) of compound **1d**.



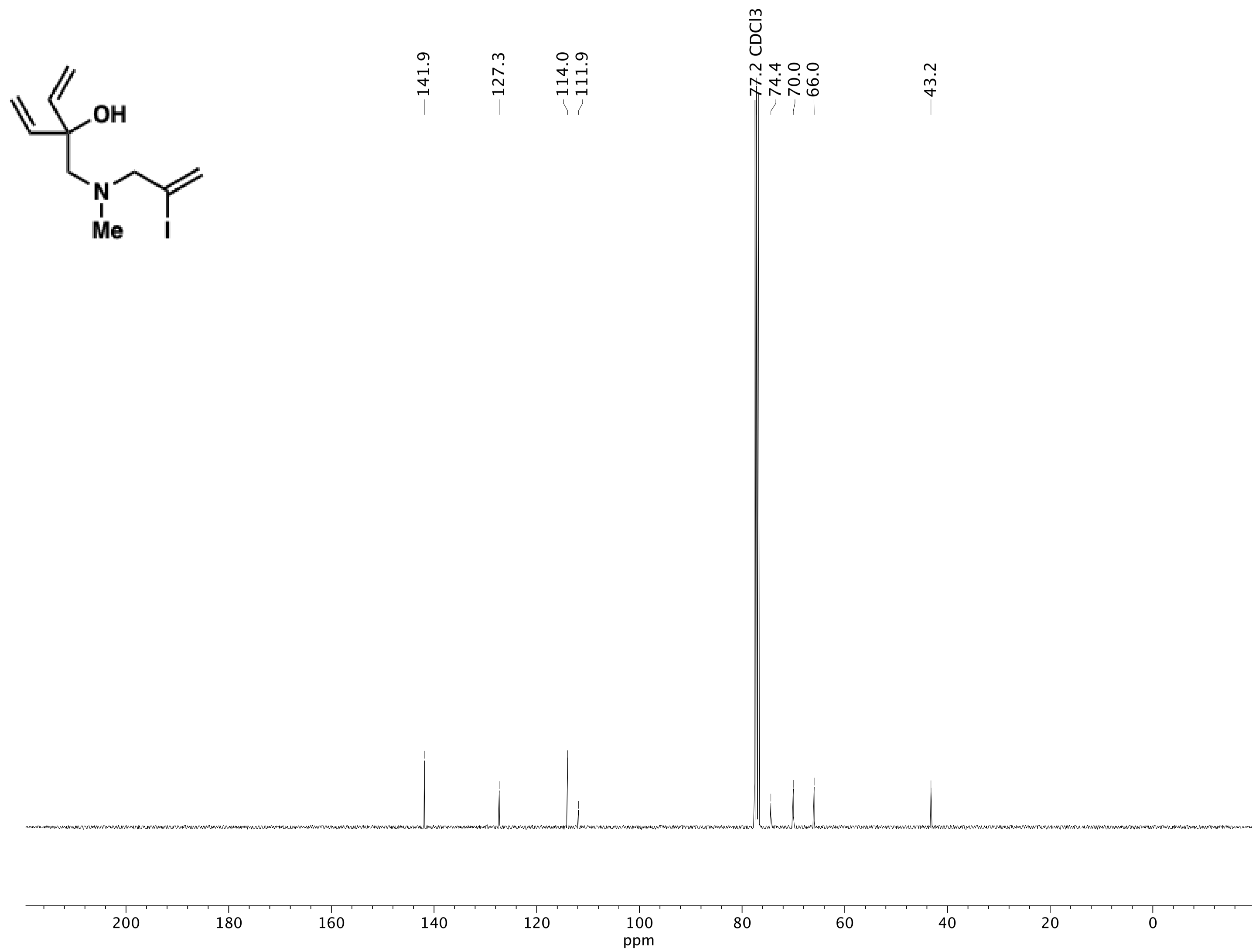
^{1}H NMR (400 MHz, $CDCl_3$) of compound **1e**.



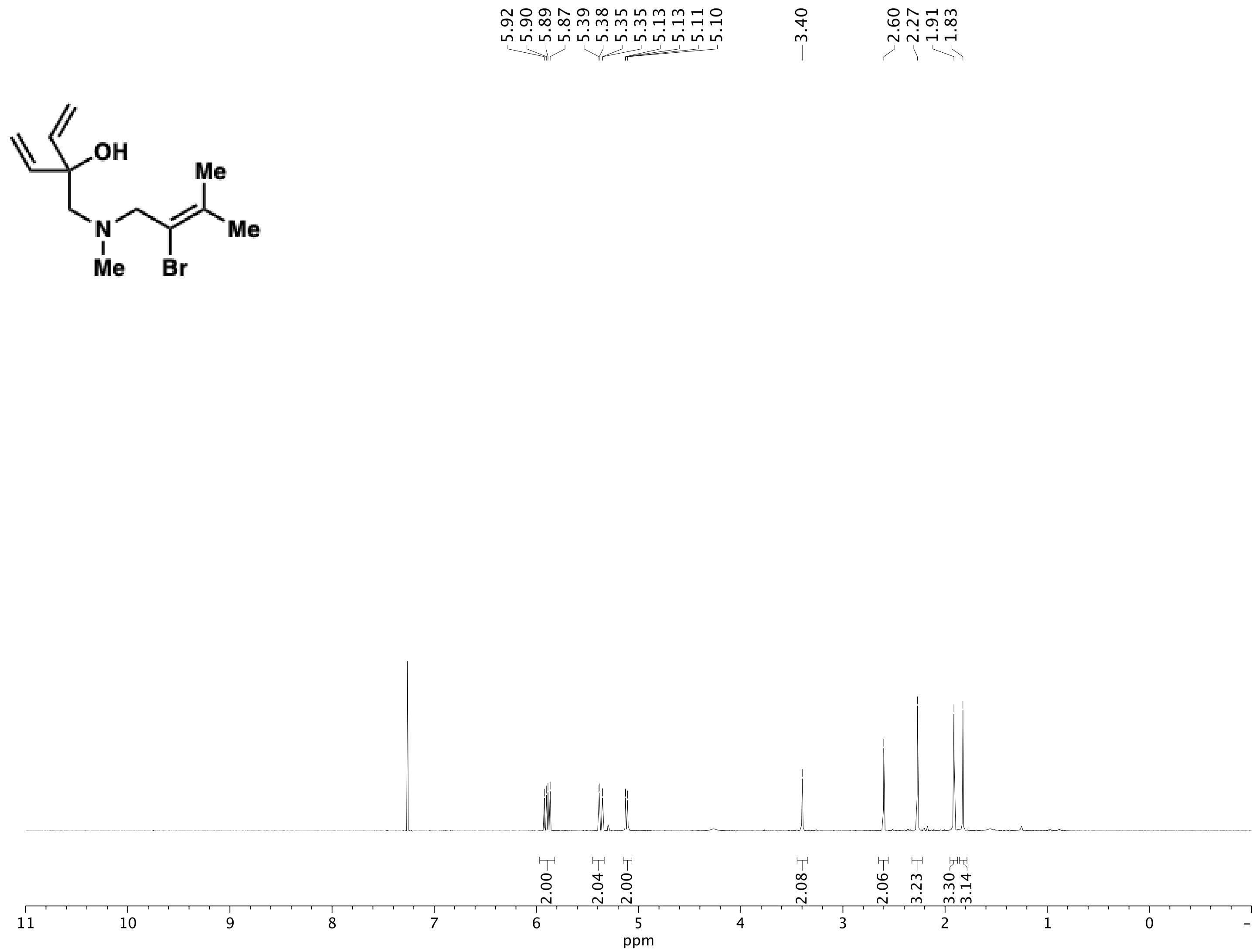
^{13}C NMR (101 MHz, $CDCl_3$) of compound **1e**.



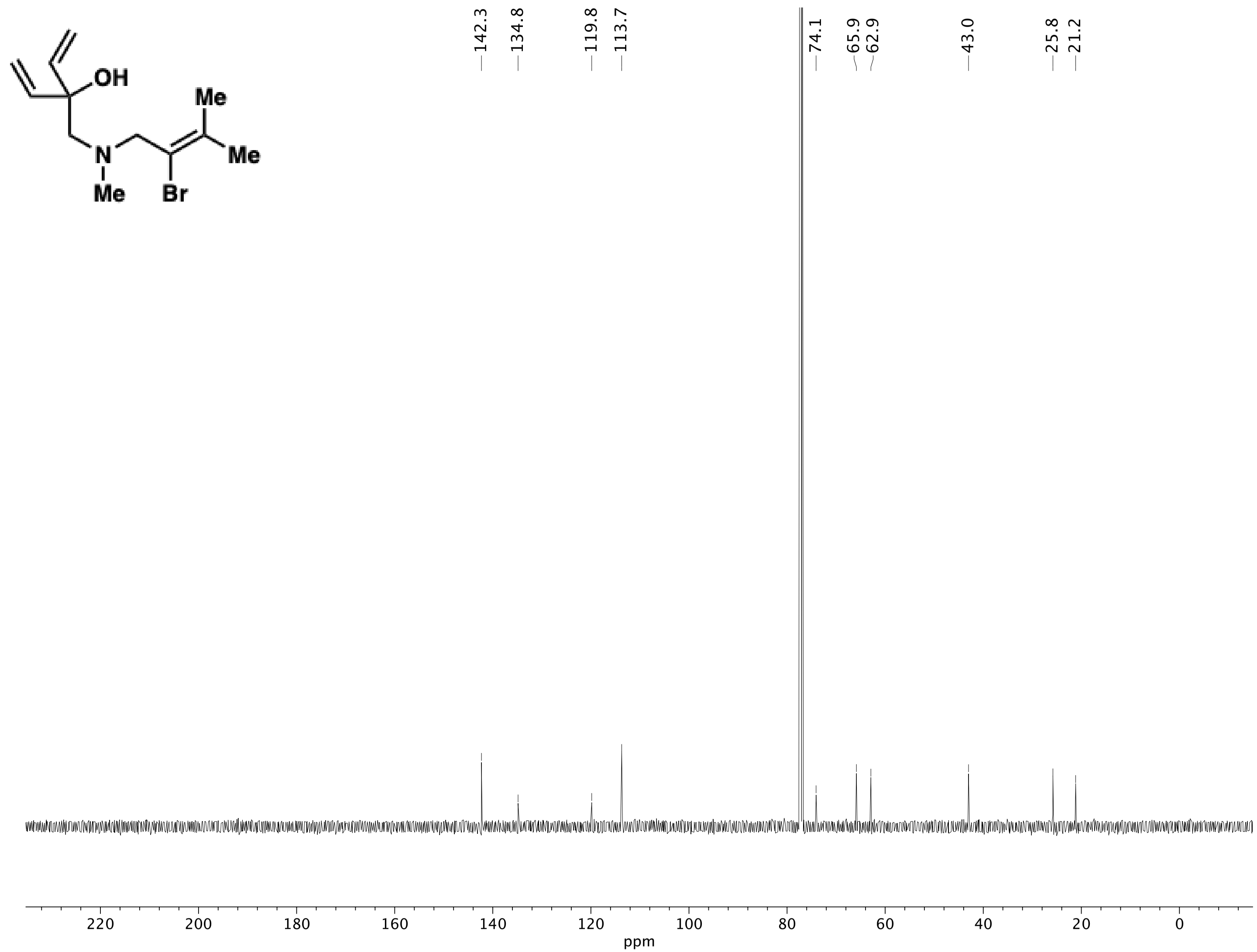
^{1}H NMR (400 MHz, $CDCl_3$) of compound **1f**.



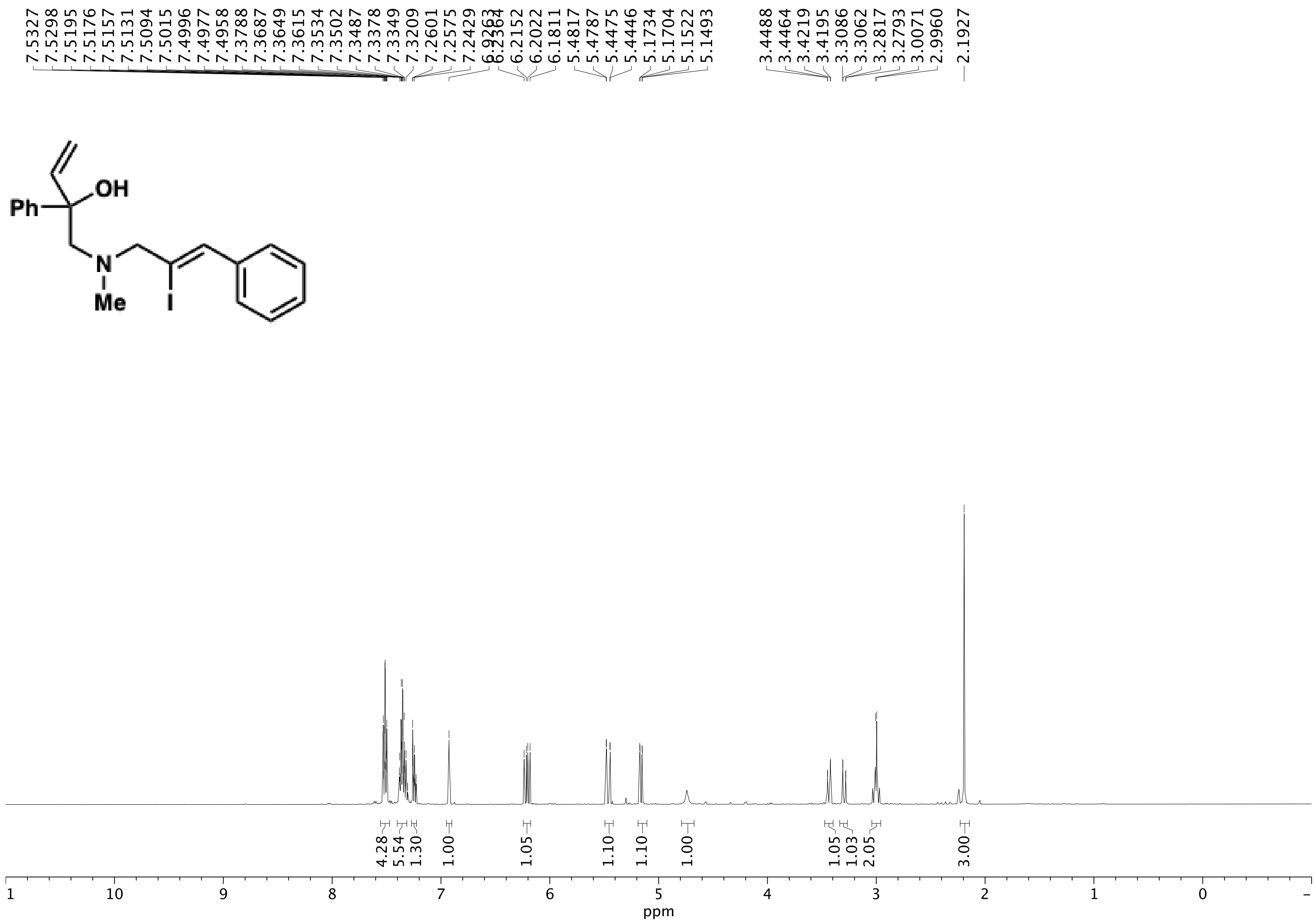
^{13}C NMR (101 MHz, $CDCl_3$) of compound **1f**.



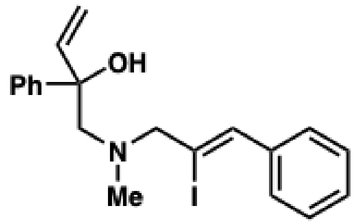
^{1}H NMR (500 MHz, $CDCl_3$) of compound **1g**.

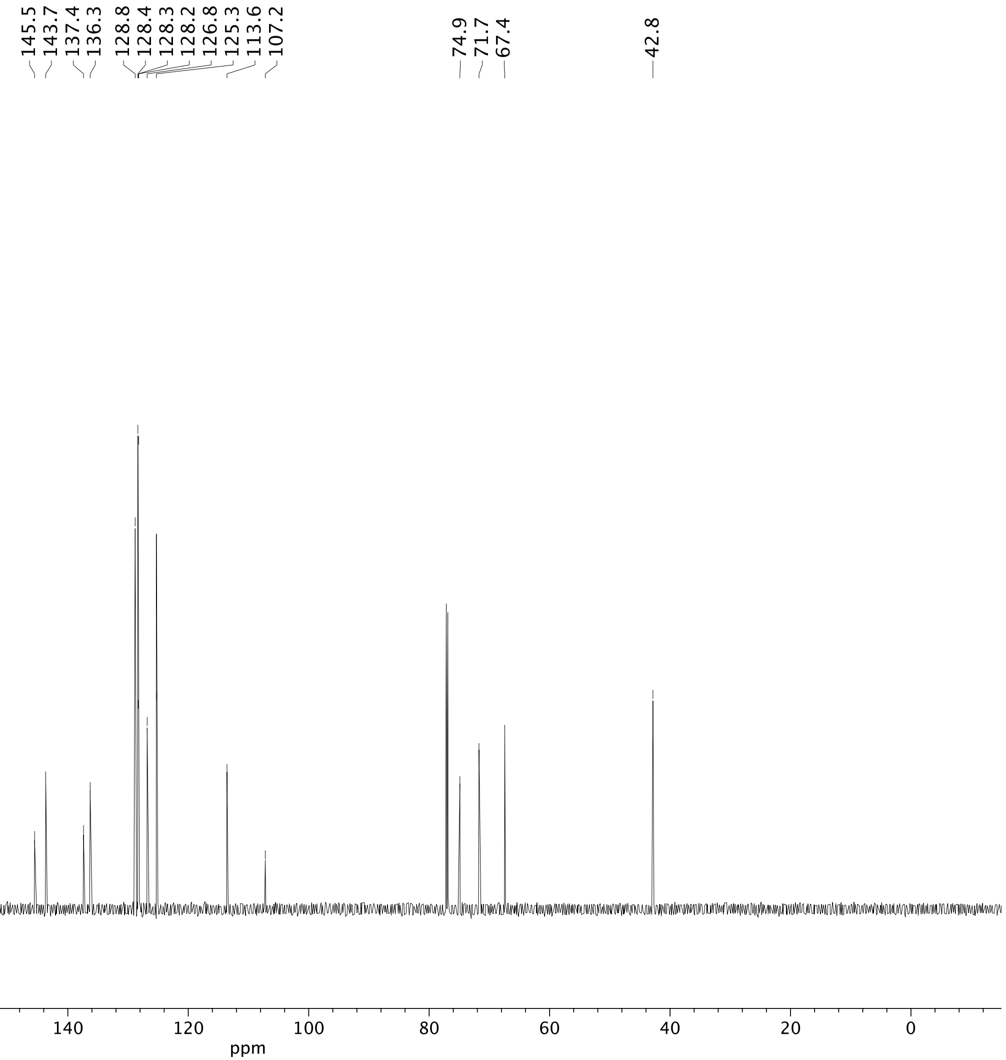


^{13}C NMR (126 MHz, $CDCl_3$) of compound **1g**.

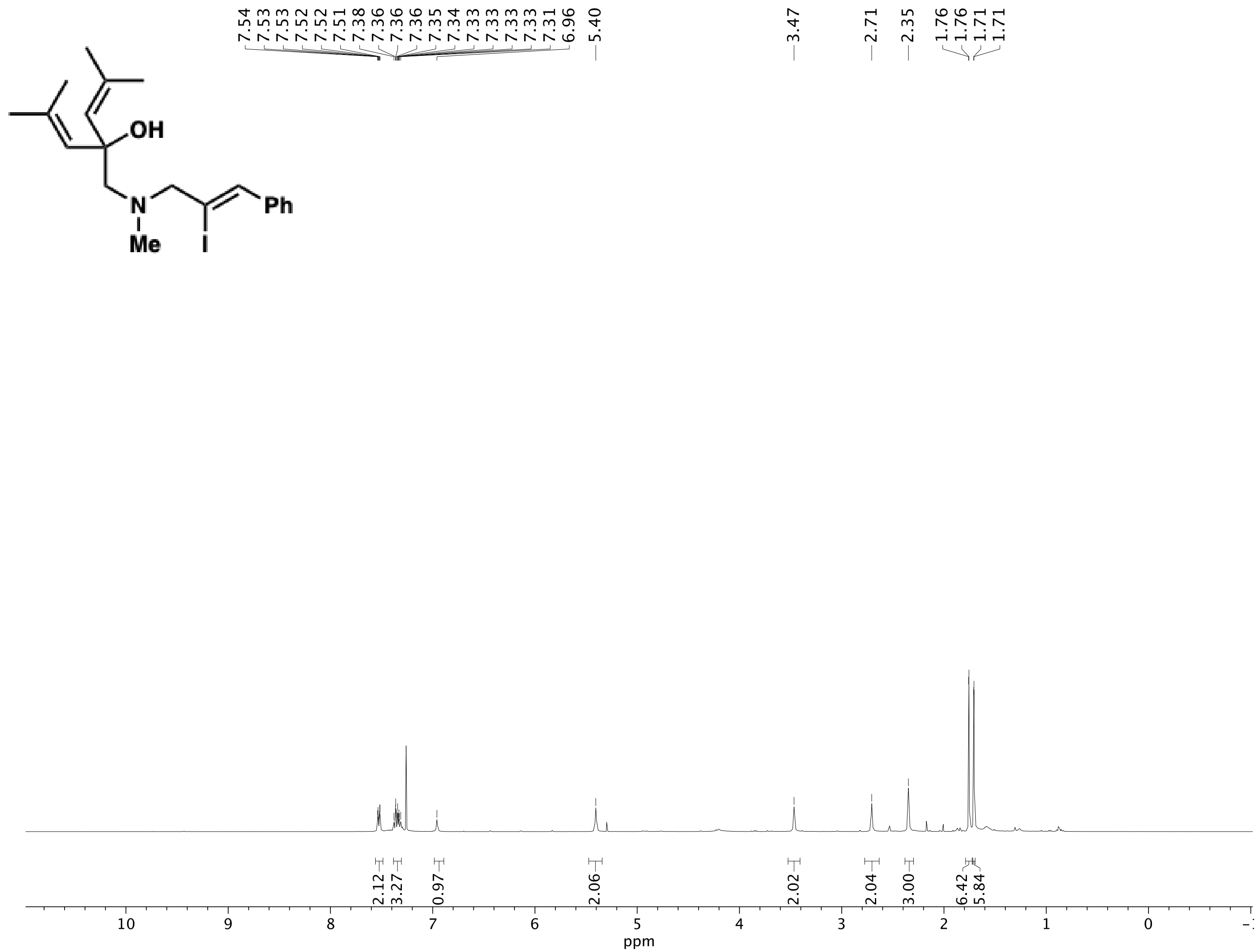


^{1}H NMR (500 MHz, $CDCl_3$) of compound **1h**.

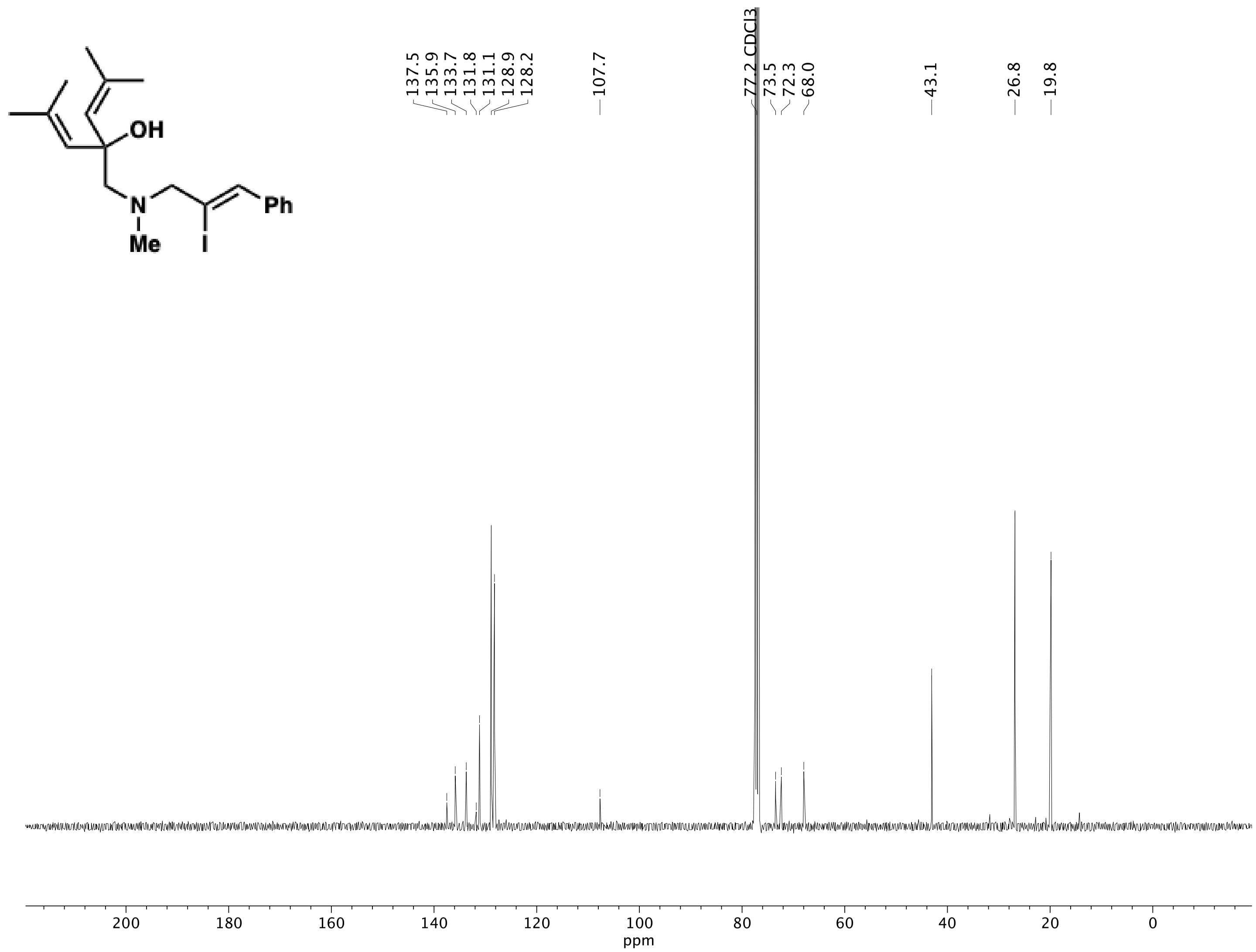




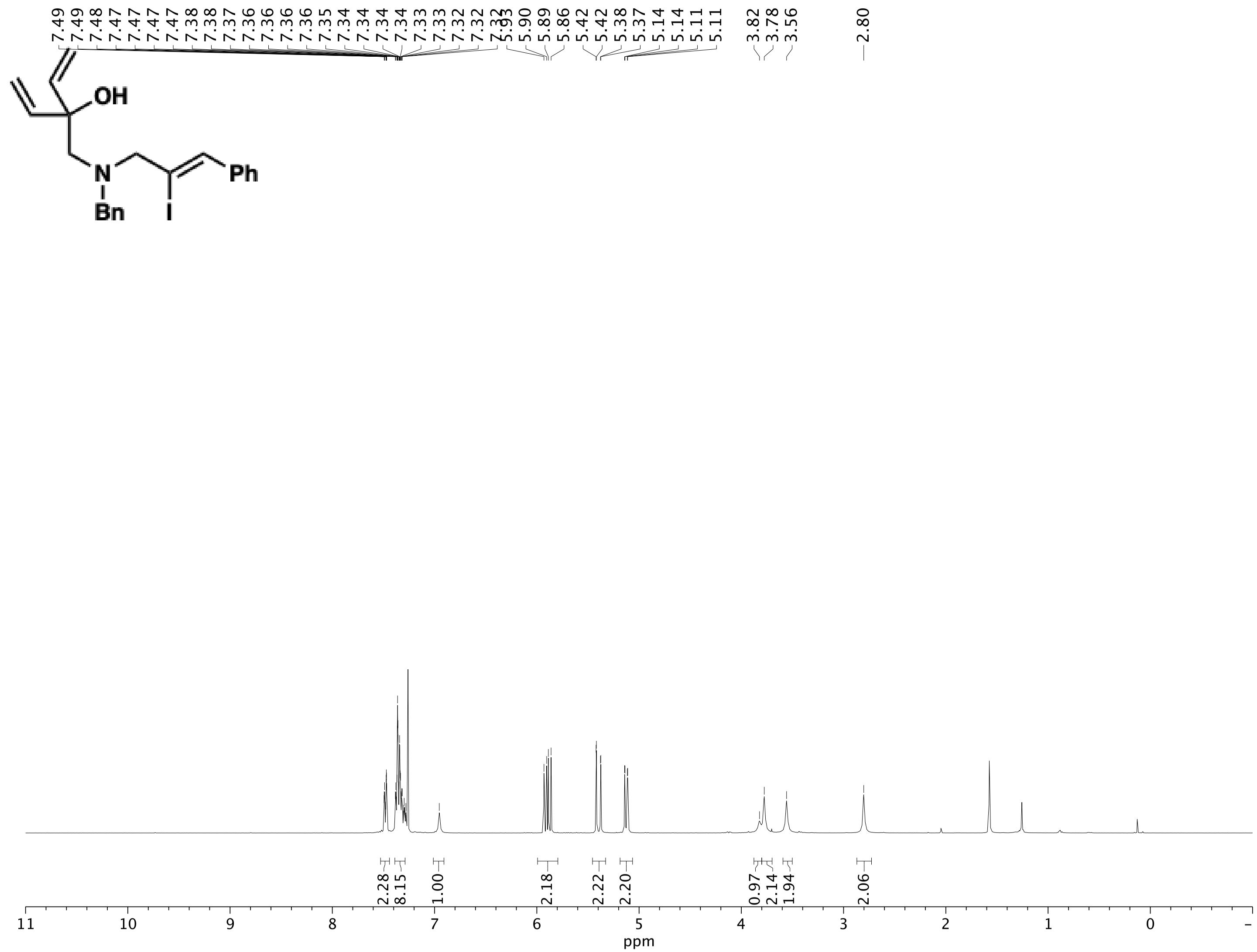
^{13}C NMR (126 MHz, $CDCl_3$) of compound **1h**.



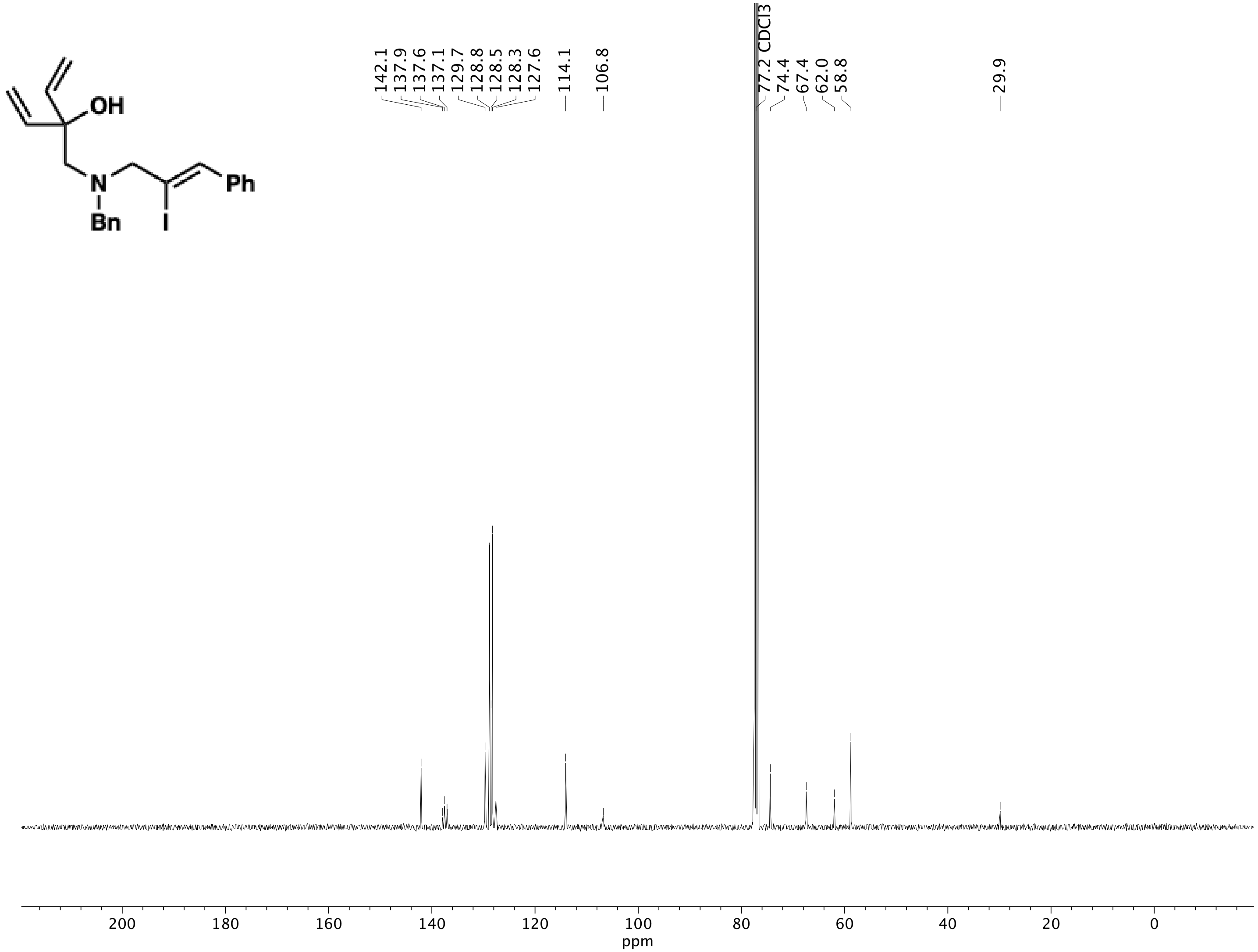
^{1}H NMR (400 MHz, $CDCl_3$) of compound **1i**.



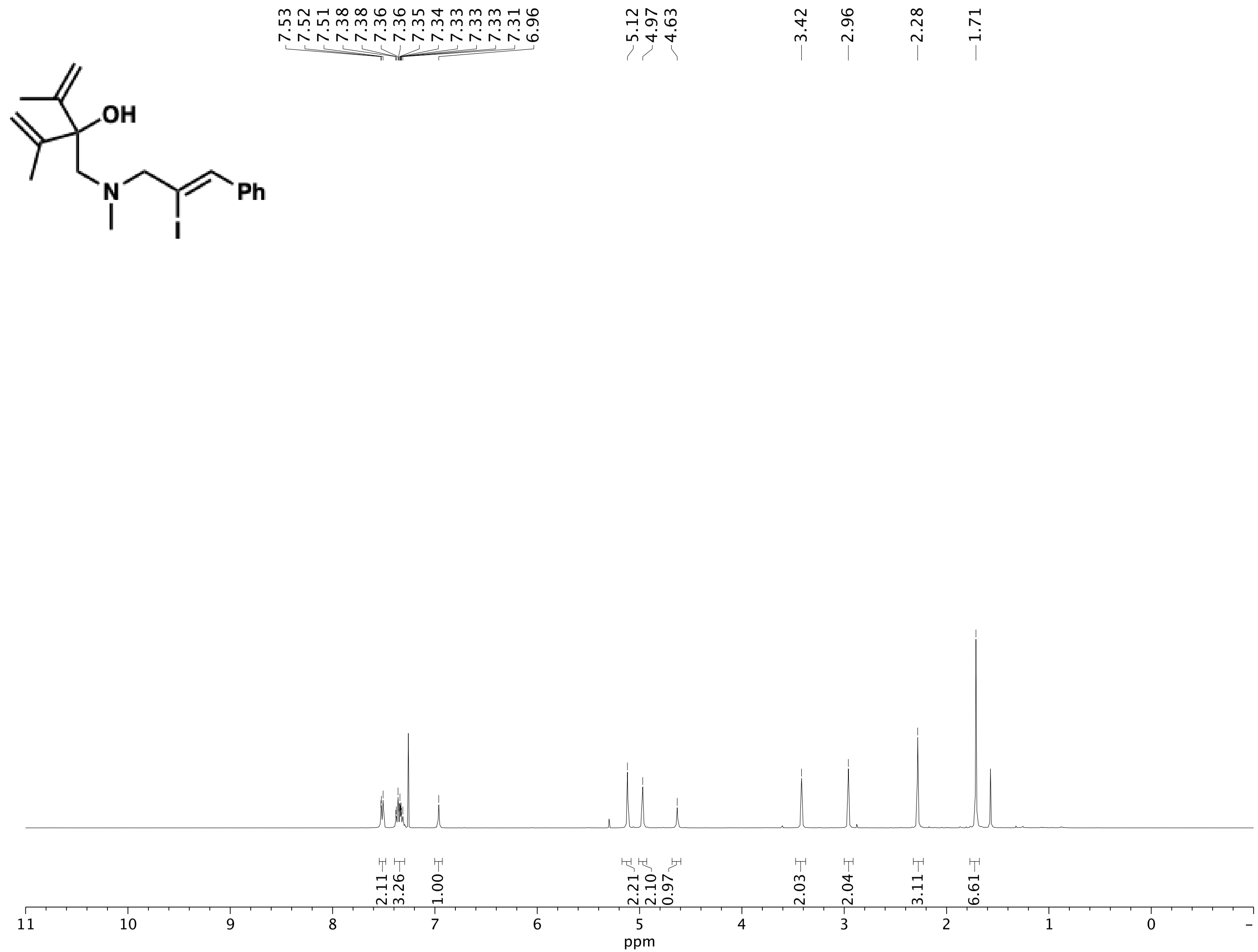
^{13}C NMR (101 MHz, $CDCl_3$) of compound **1i**.



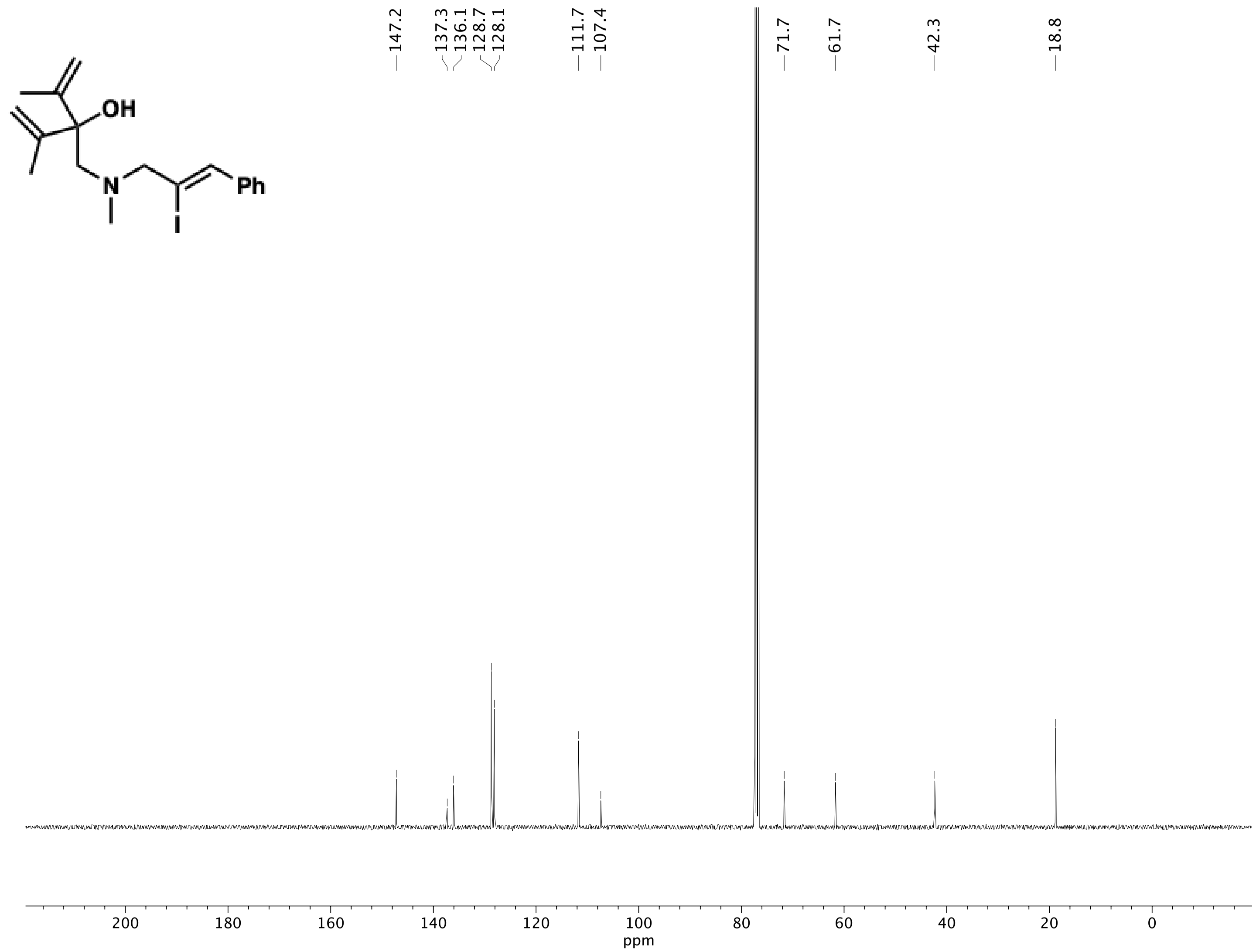
^{1}H NMR (400 MHz, $CDCl_3$) of compound **1j**.



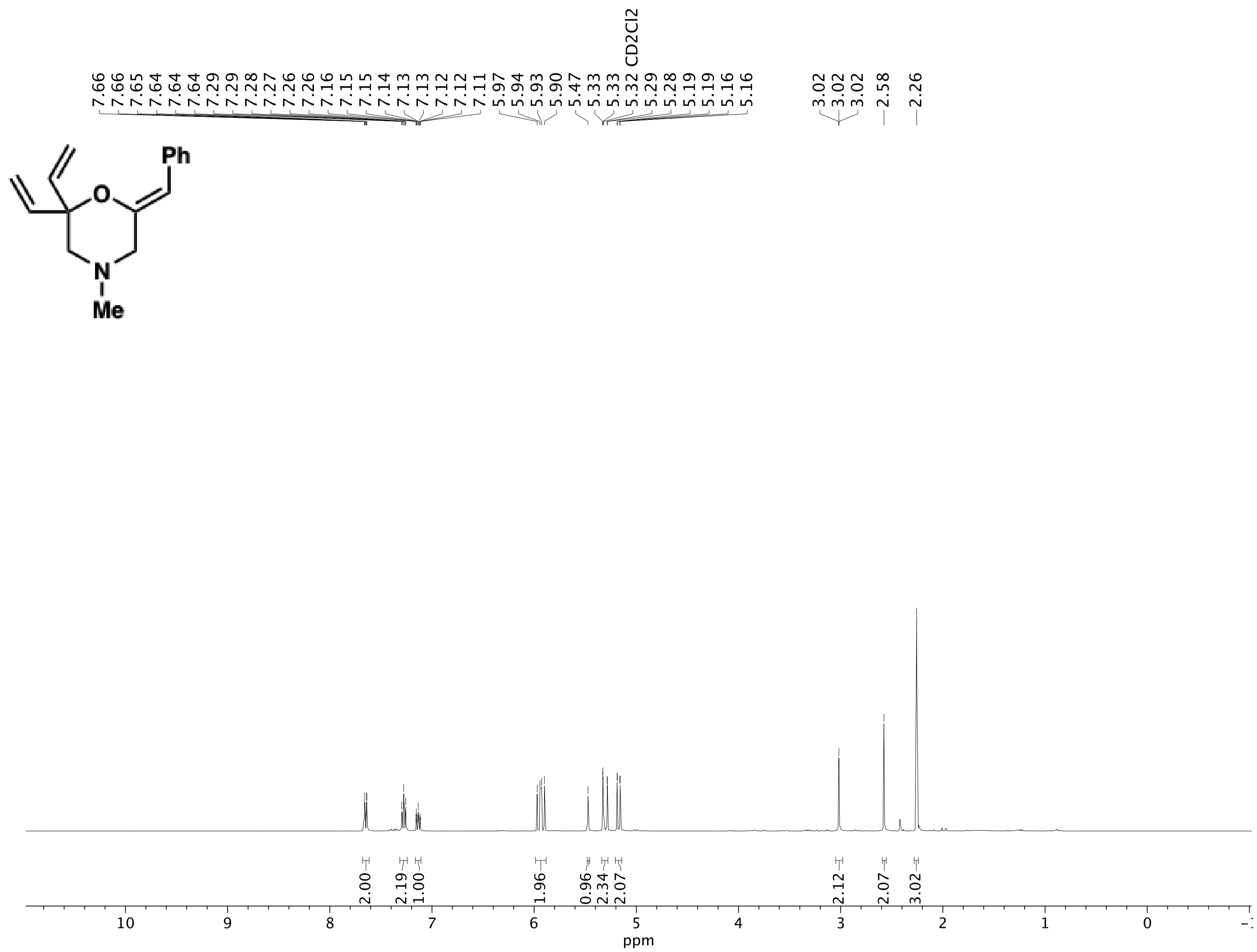
^{13}C NMR (101 MHz, $CDCl_3$) of compound **1j**.



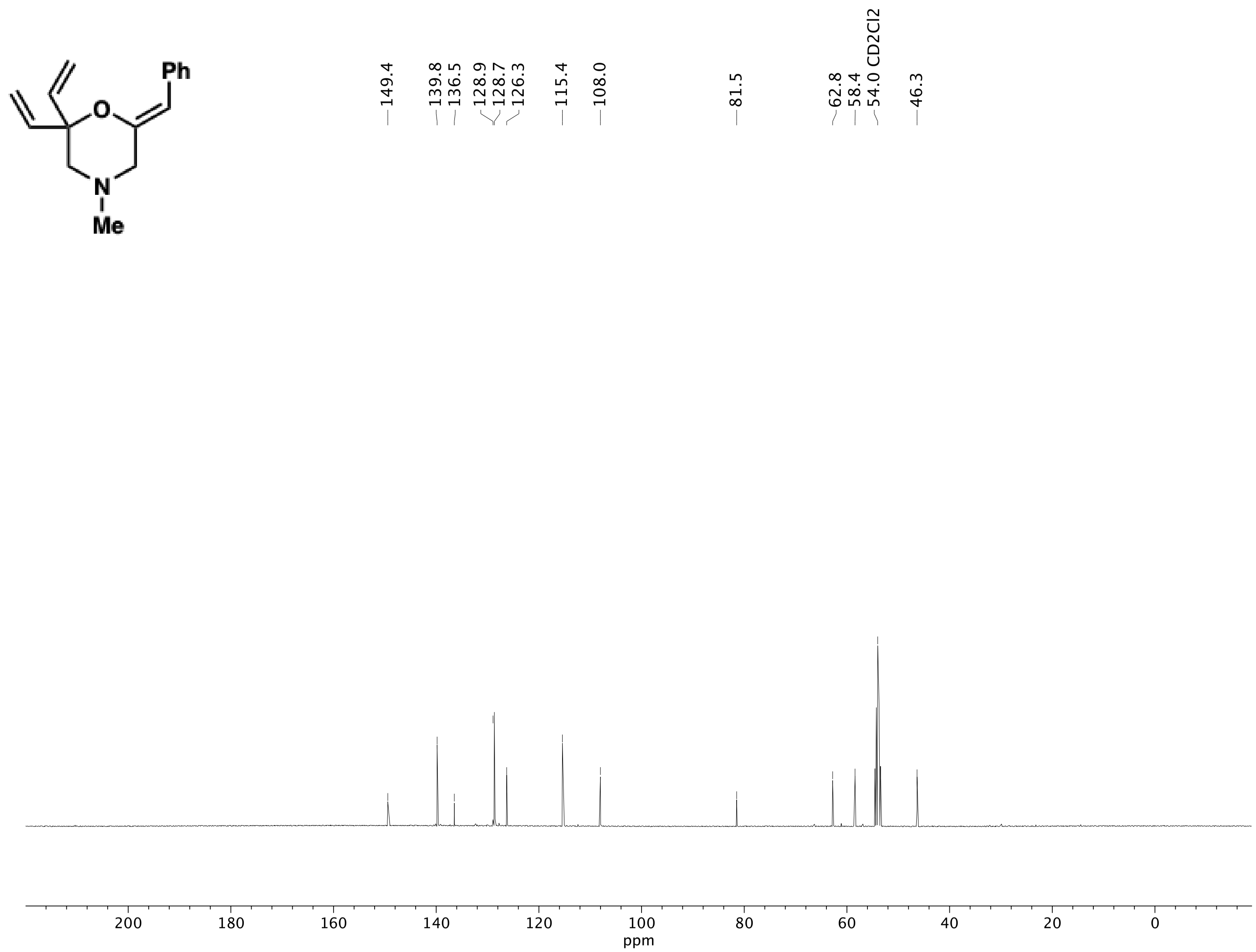
^{1}H NMR (400 MHz, $CDCl_3$) of compound **1k**.



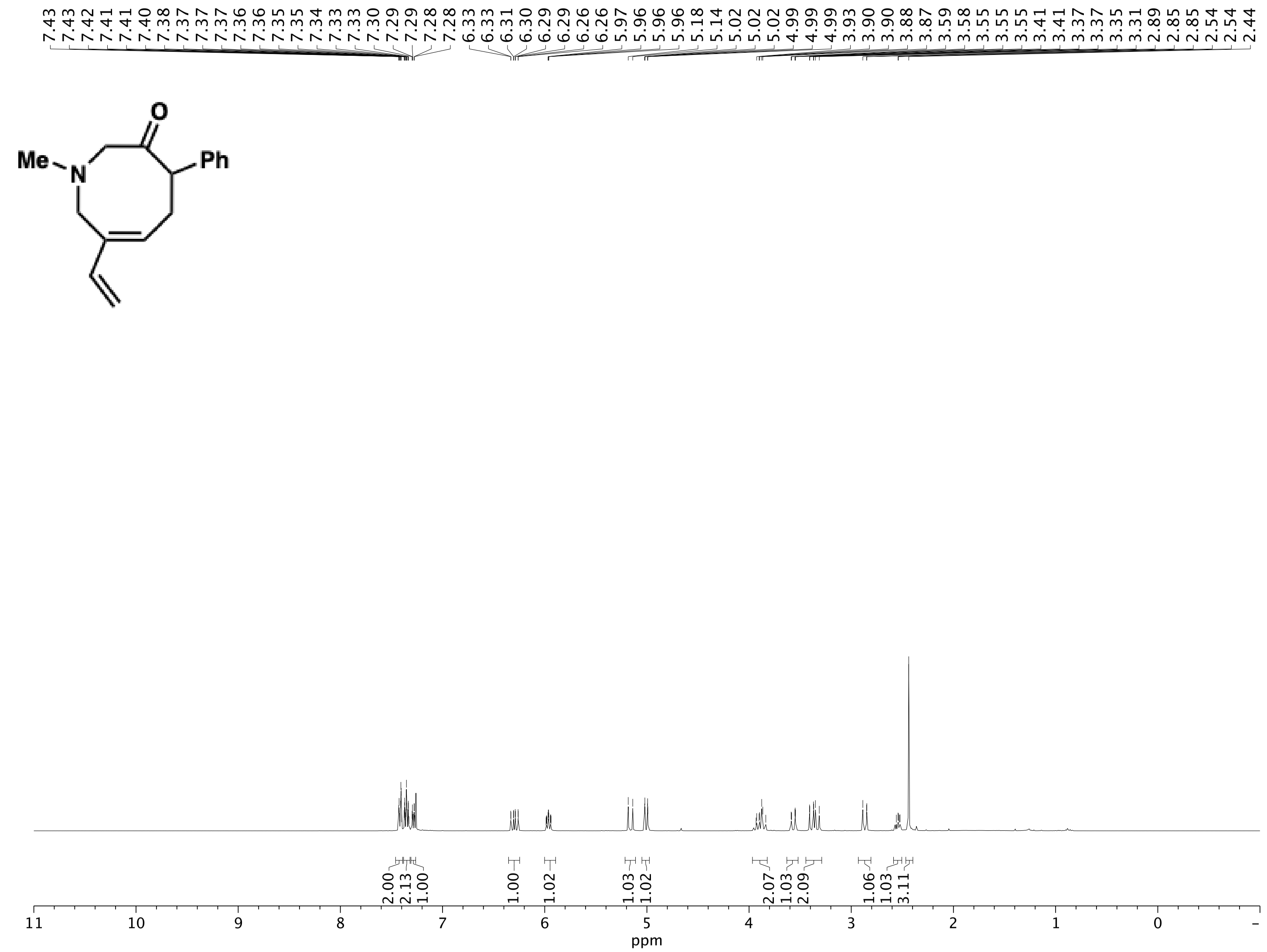
^{13}C NMR (101 MHz, $CDCl_3$) of compound **1k**.



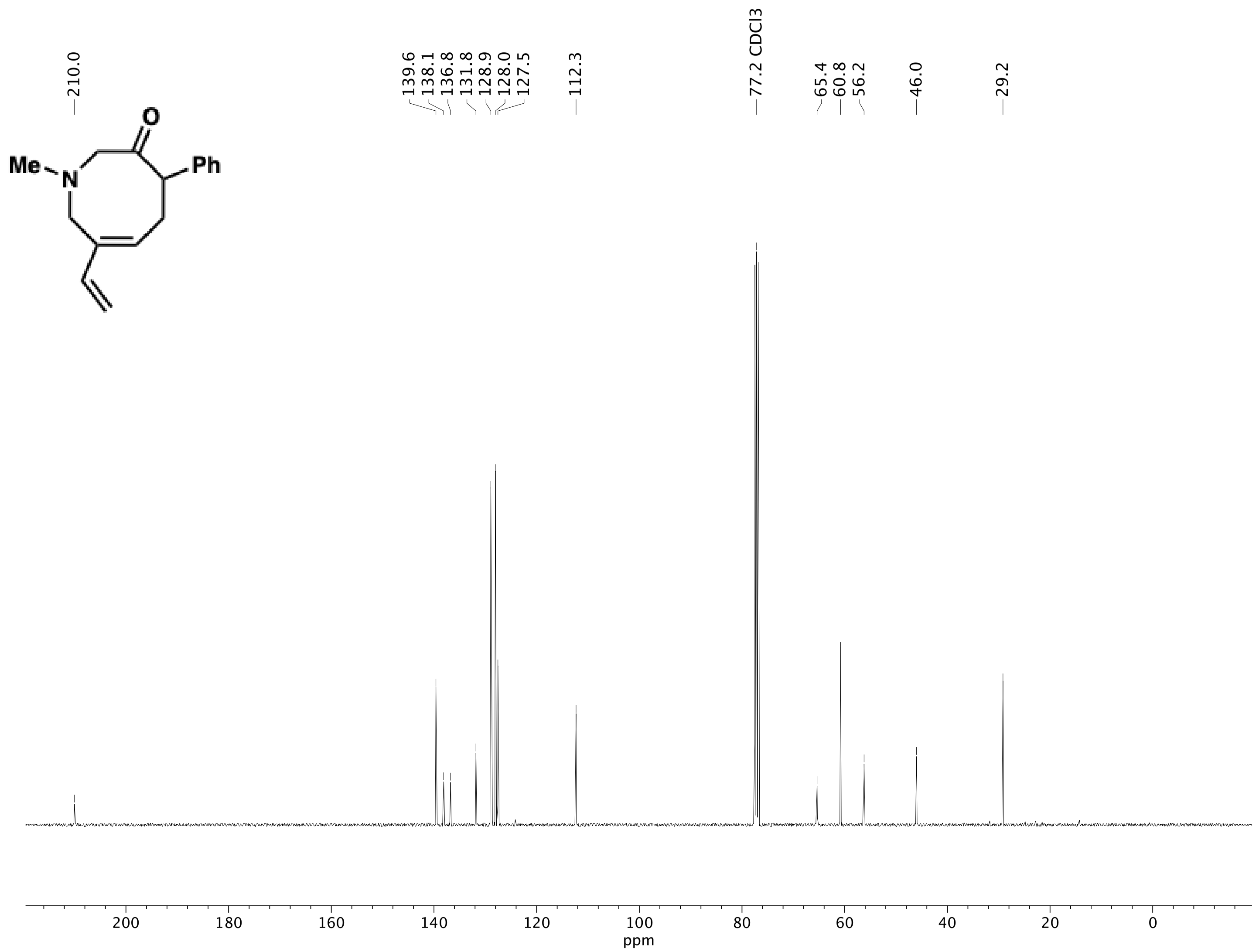
^{1}H NMR (400 MHz, CD_2Cl_2) of compound **2b**.



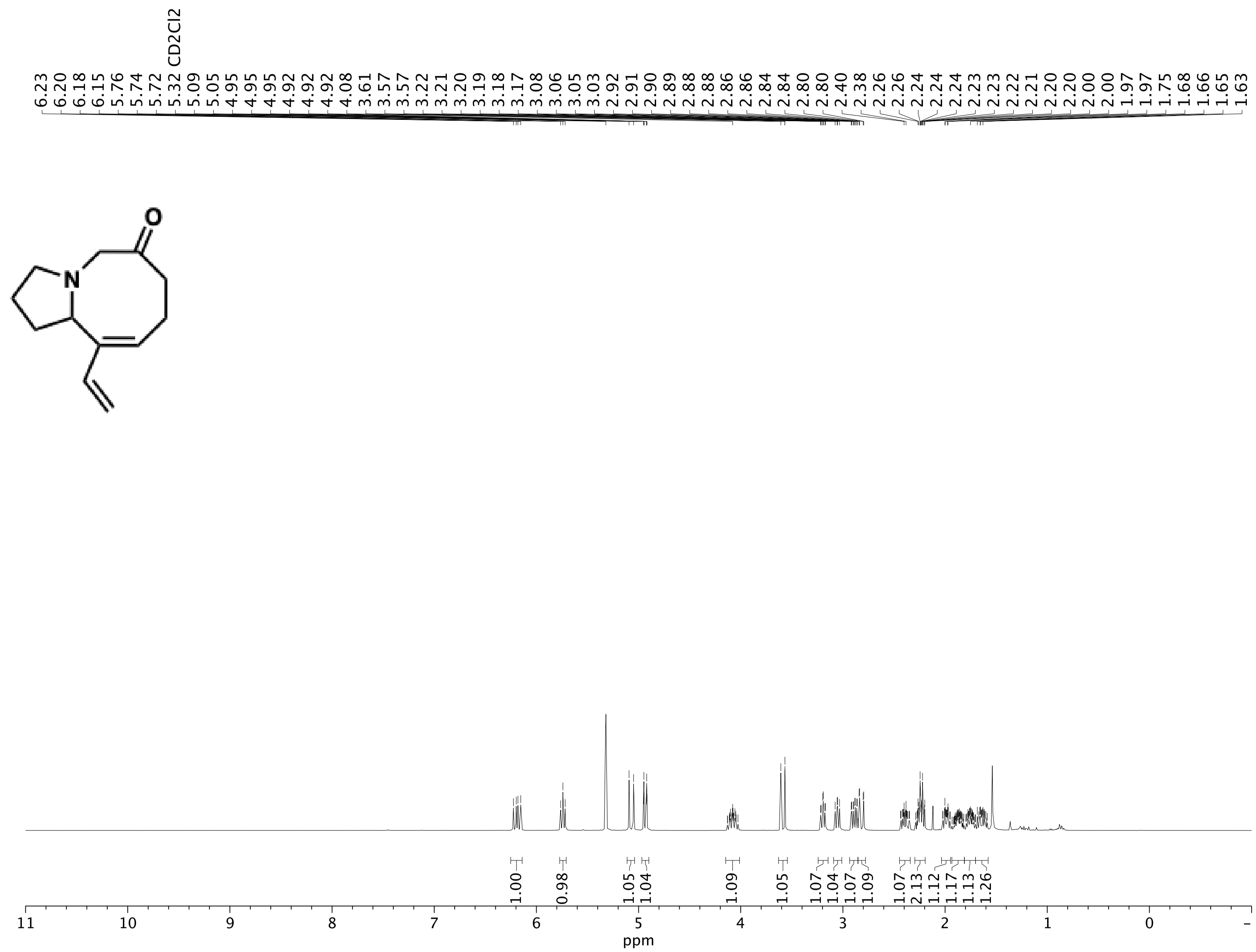
^{13}C NMR (101 MHz, CD_2Cl_2) of compound **2b**.



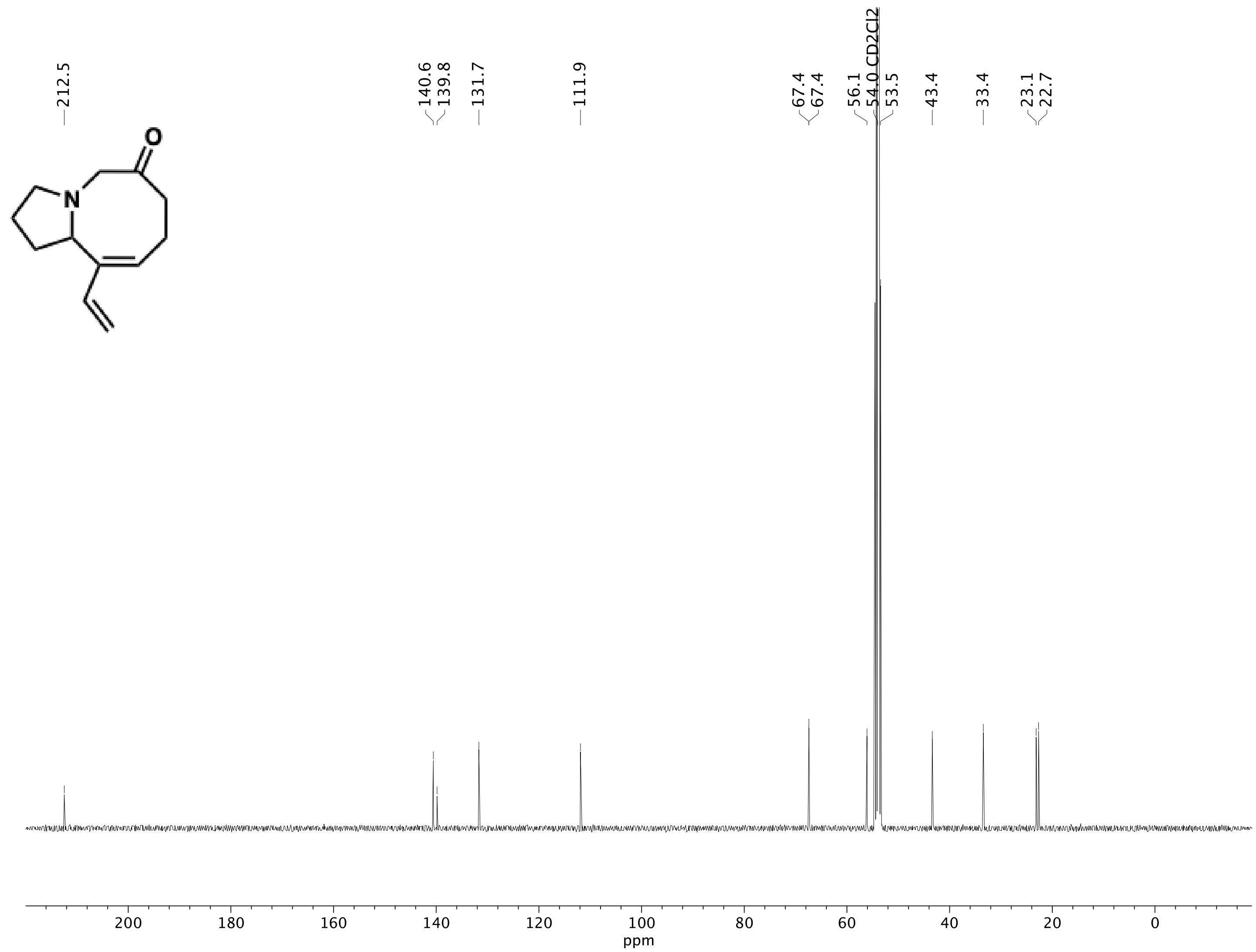
[1]H NMR (400 MHz, $CDCl_3$) of compound **3b**.



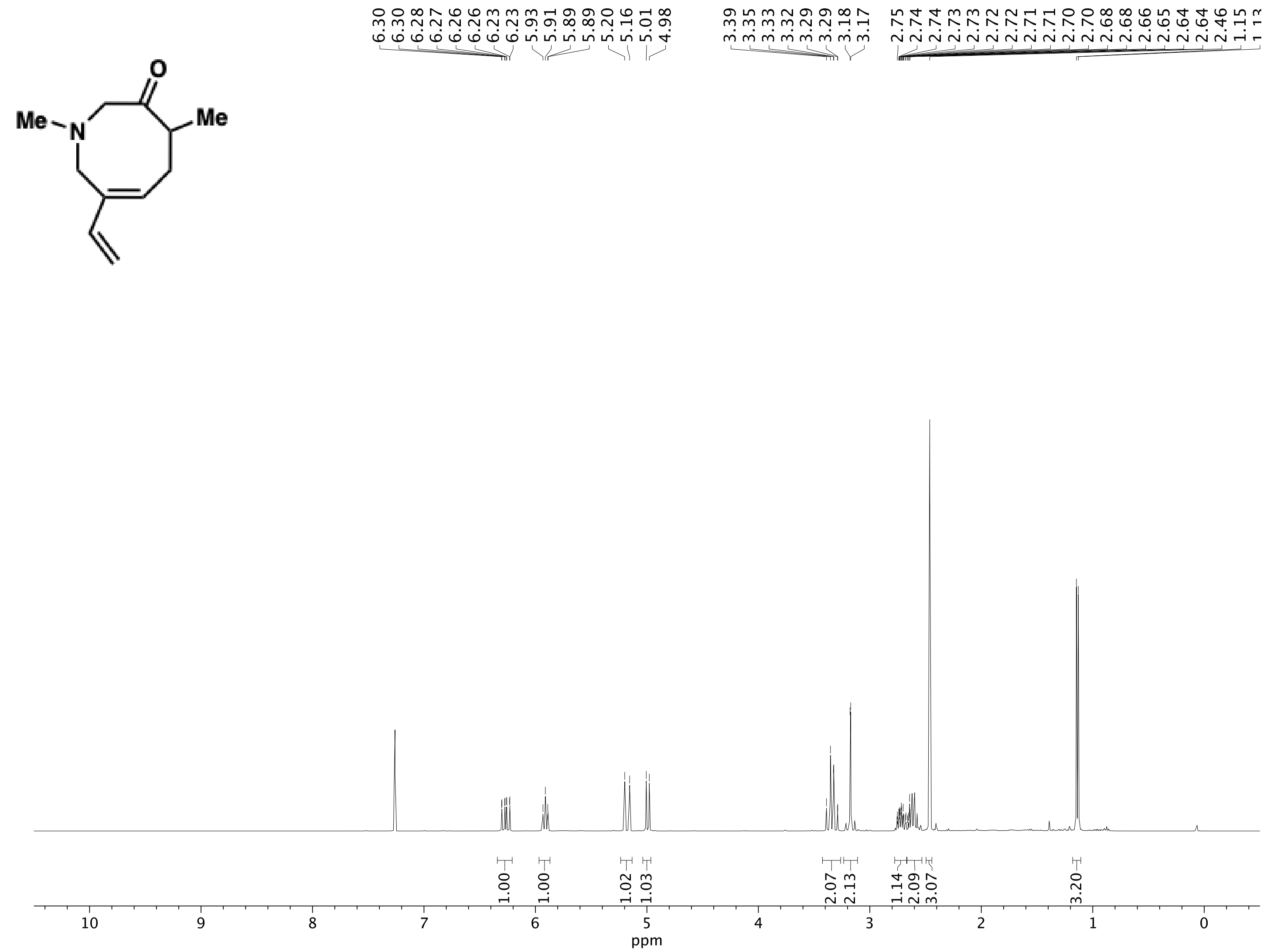
^{13}C NMR (101 MHz, $CDCl_3$) of compound **3b**.



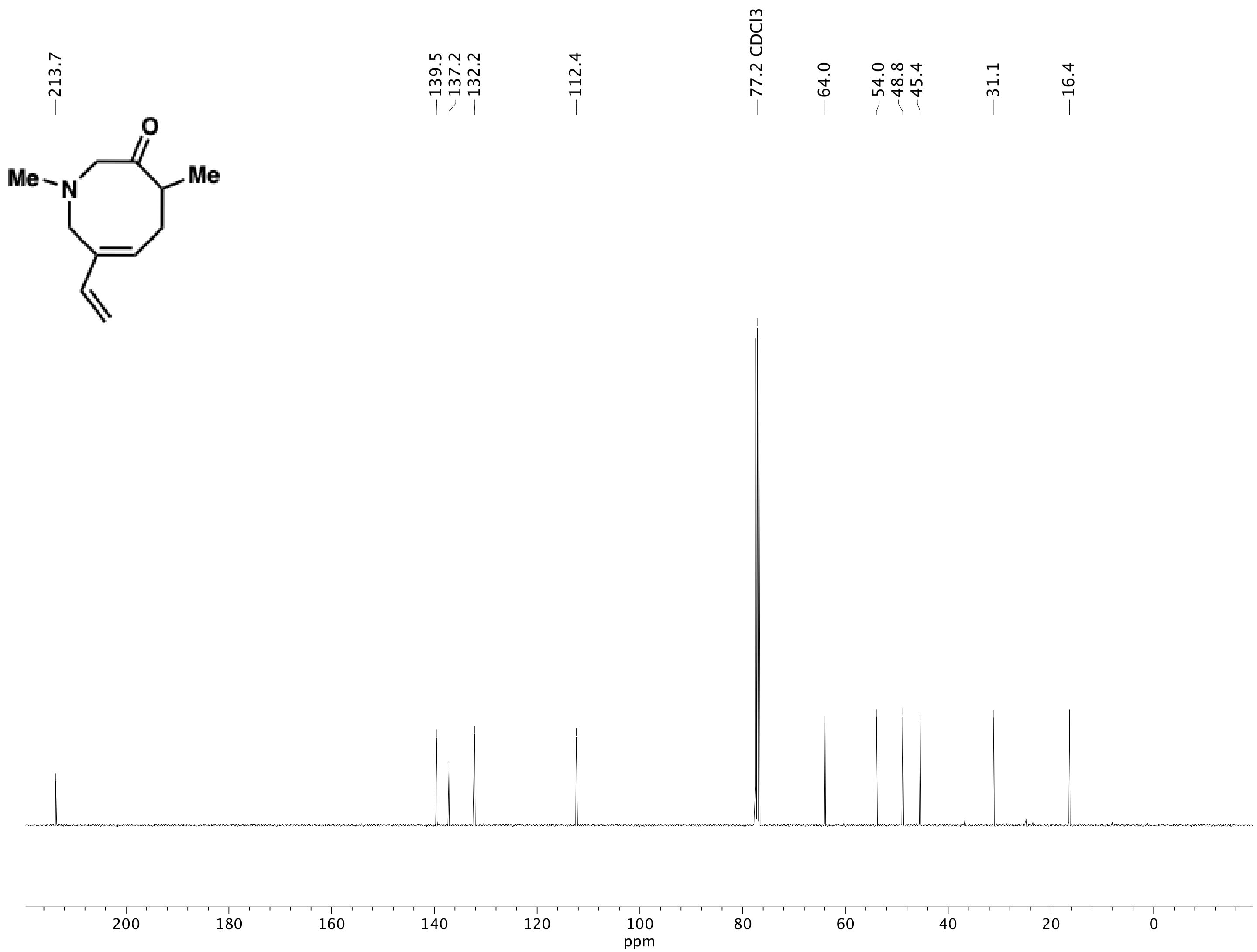
^{1}H NMR (400 MHz, CD_2Cl_2) of compound **3c**.



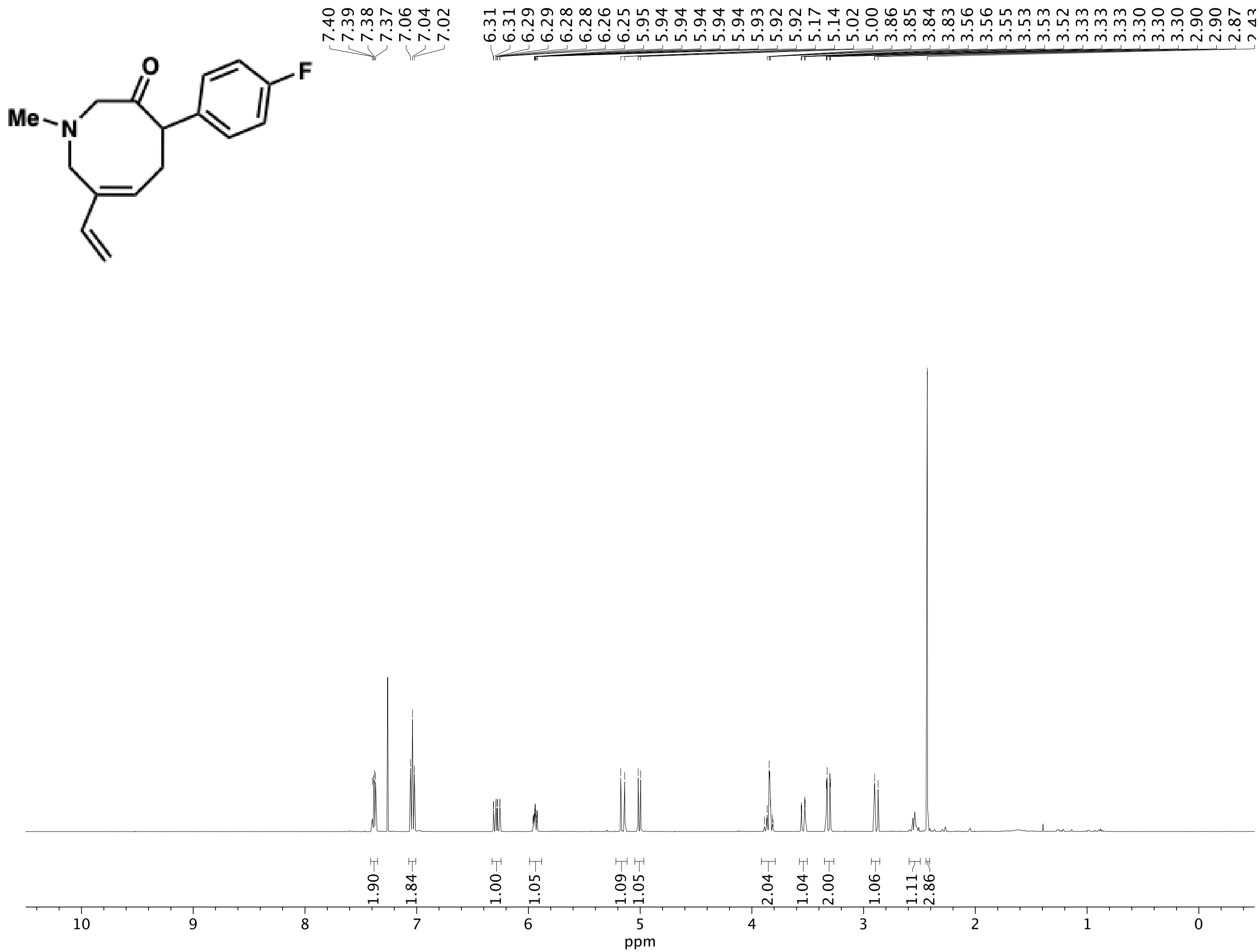
^{13}C NMR (101 MHz, CD_2Cl_2) of compound **3c**.



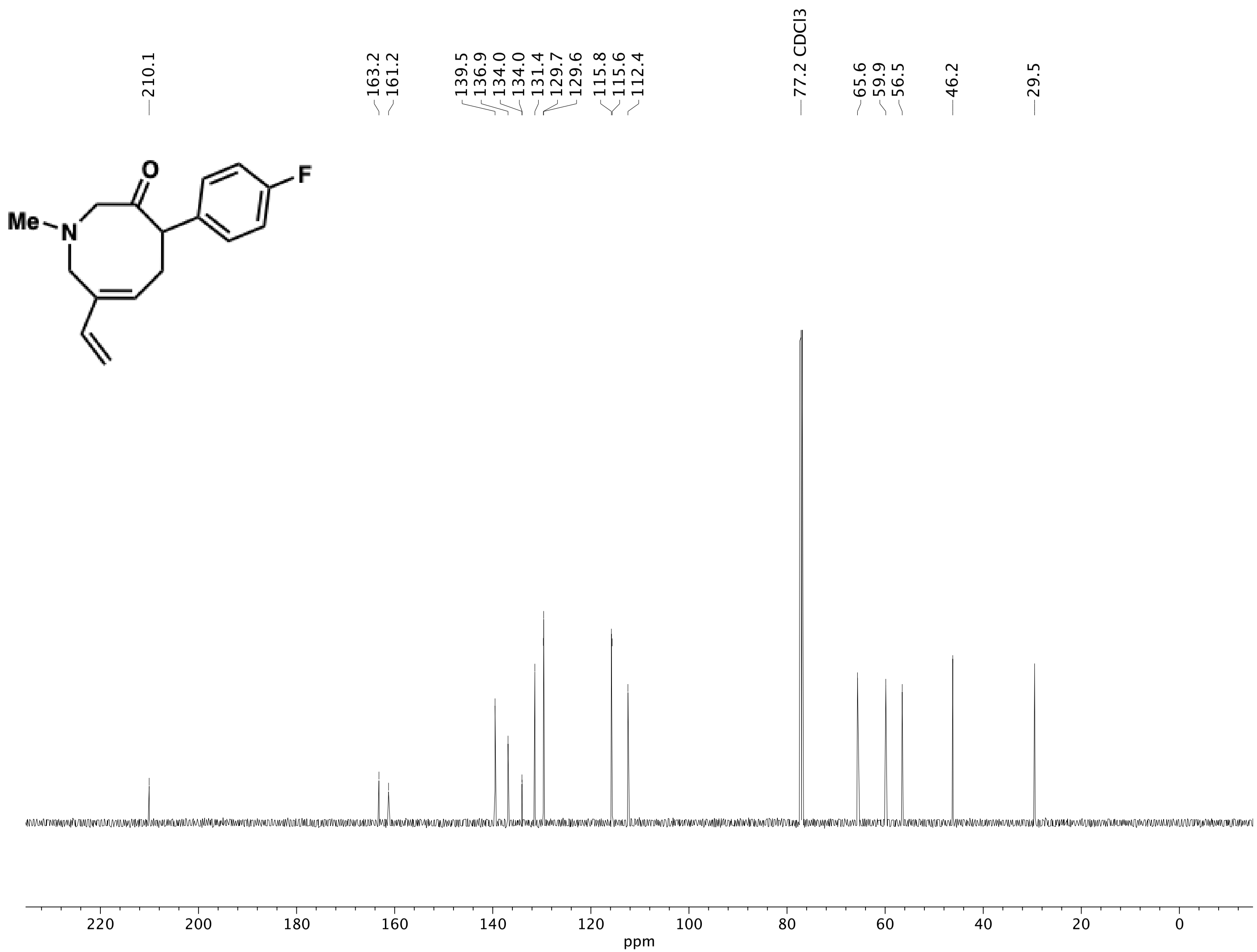
^{1}H NMR (400 MHz, $CDCl_3$) of compound **3d**.



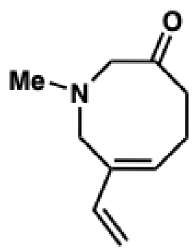
^{13}C NMR (101 MHz, $CDCl_3$) of compound **3d**.

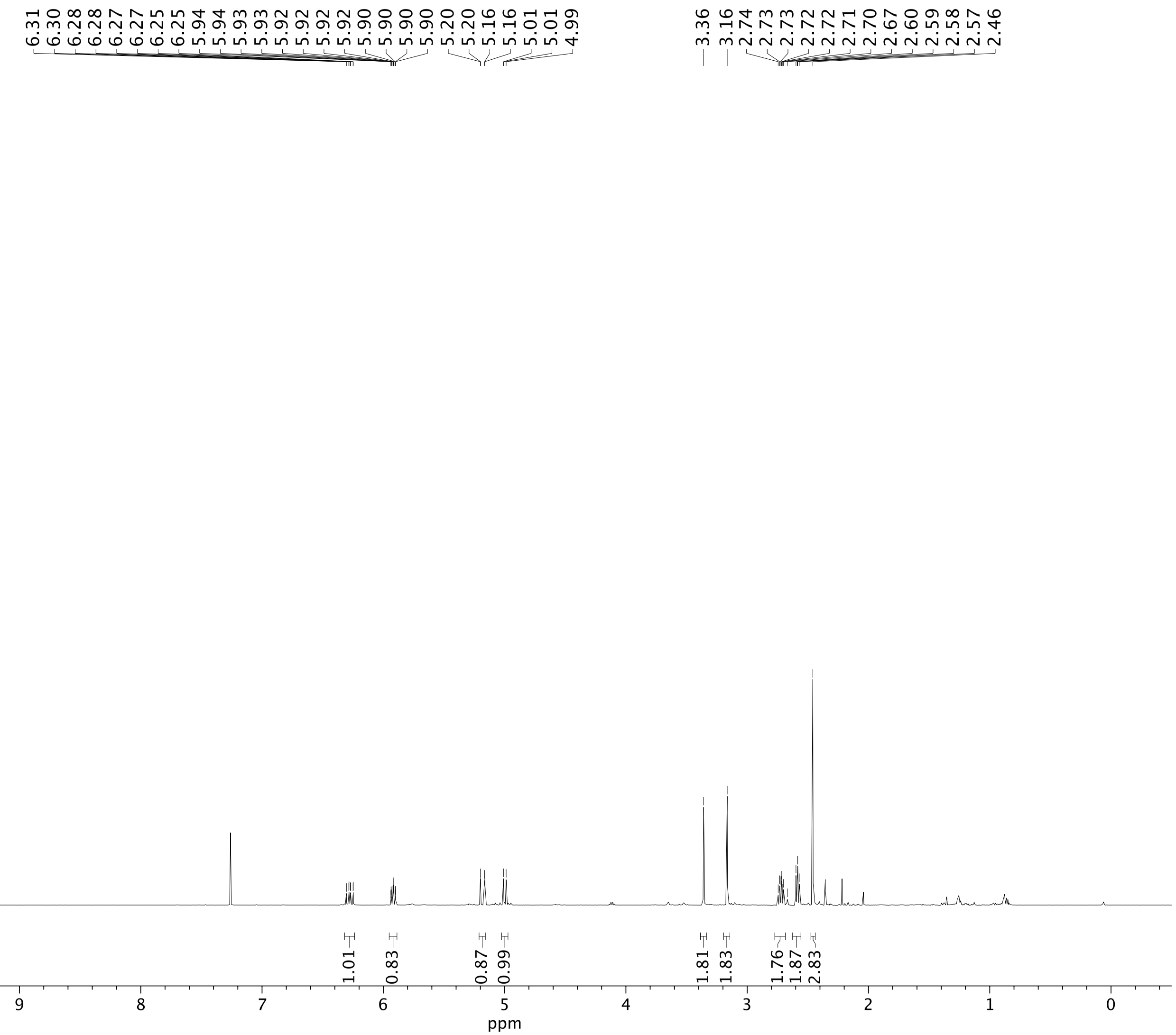


^{1}H NMR (500 MHz, $CDCl_3$) of compound **3e**.

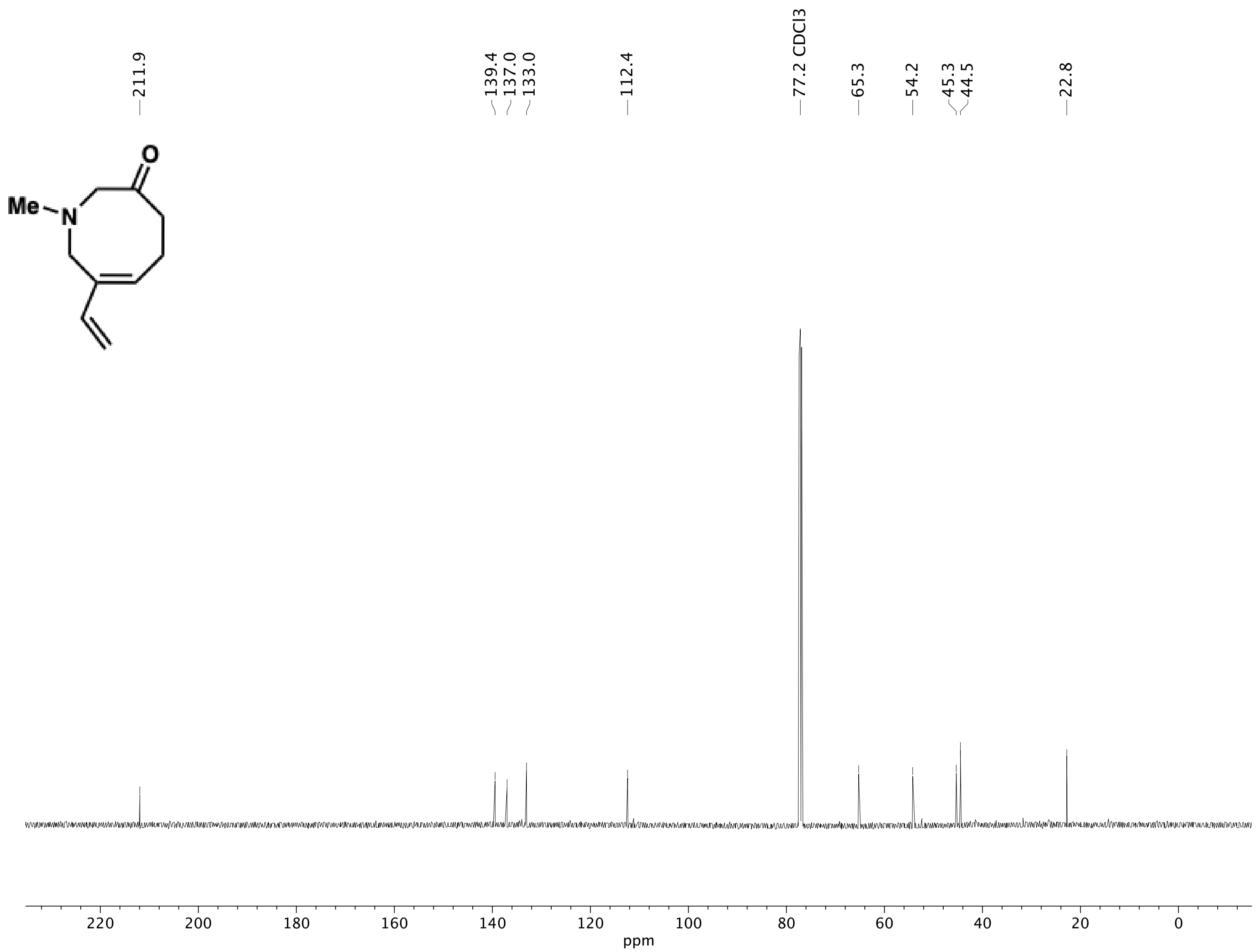


^{13}C NMR (126 MHz, $CDCl_3$) of compound **3e**.

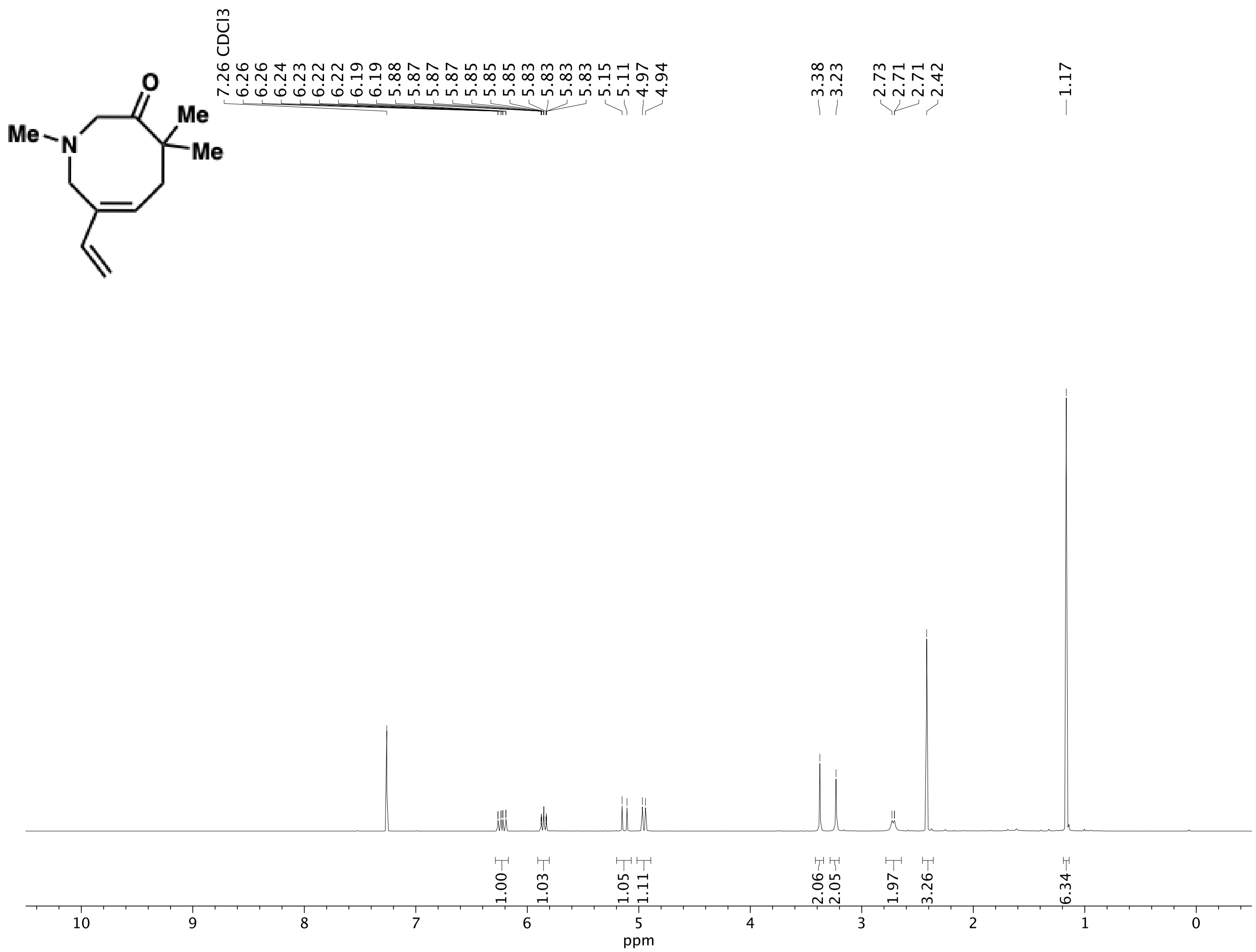




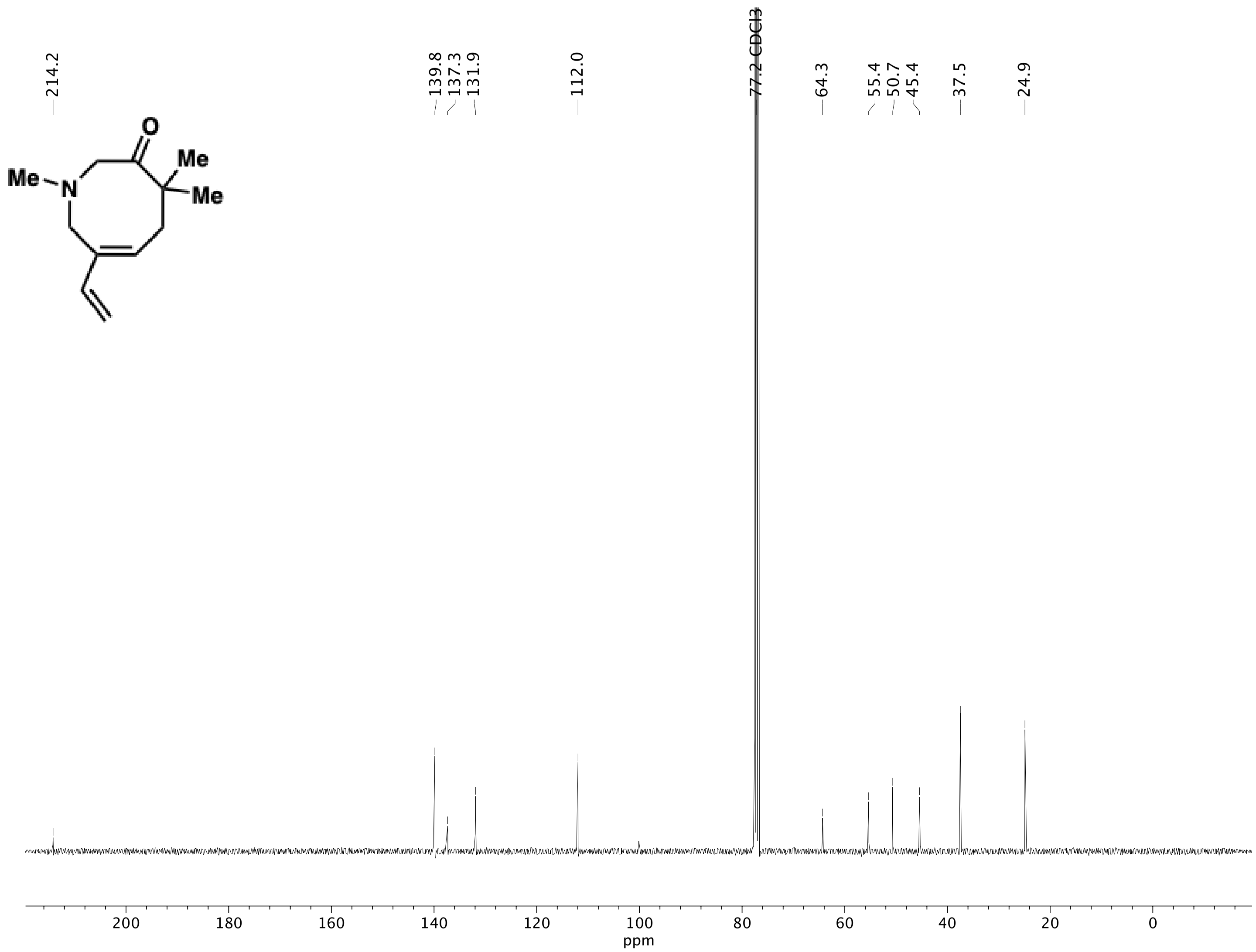
[1]H NMR (500 MHz, $CDCl_3$) of compound **3f**.



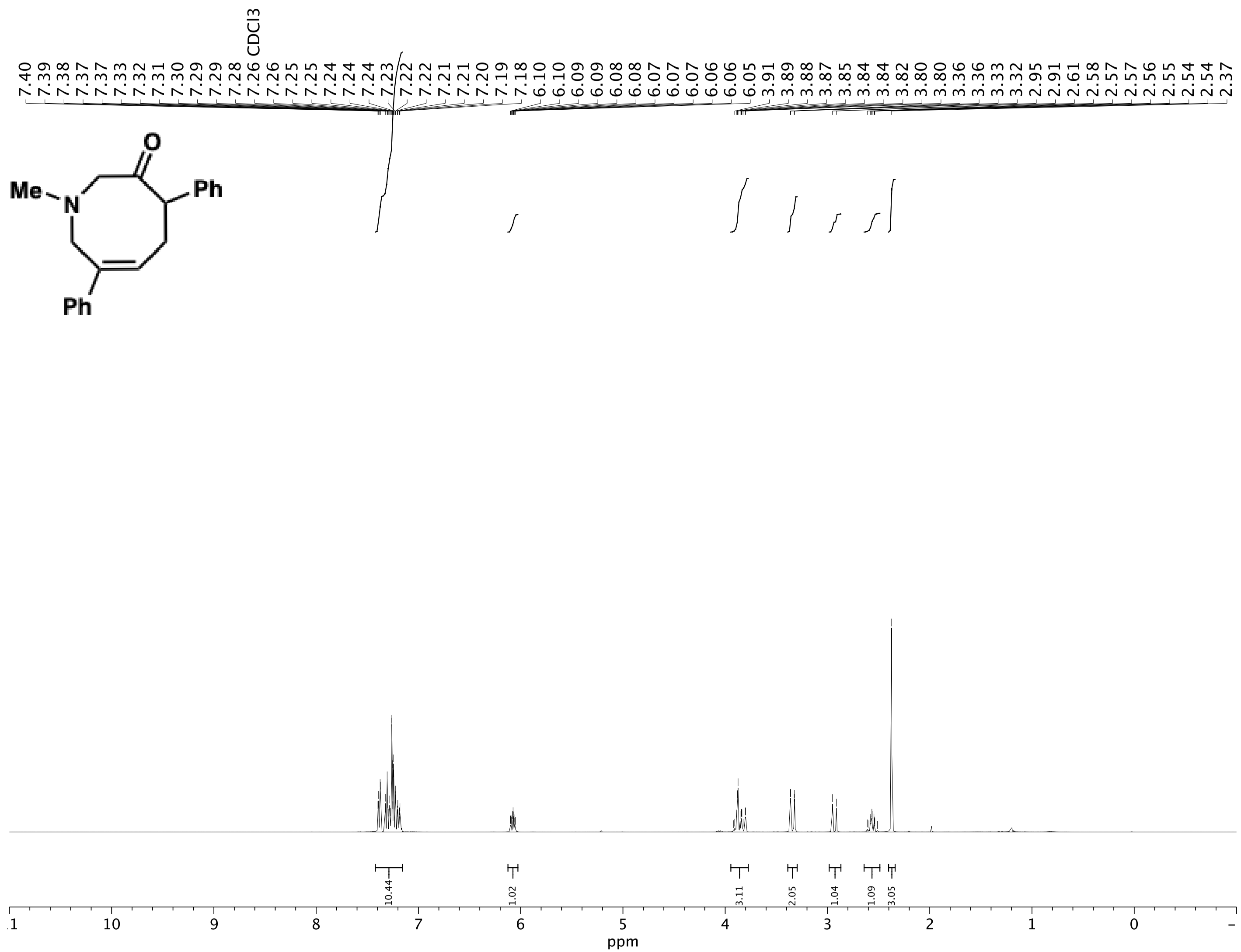
^{13}C NMR (126 MHz, $CDCl_3$) of compound **3f.**



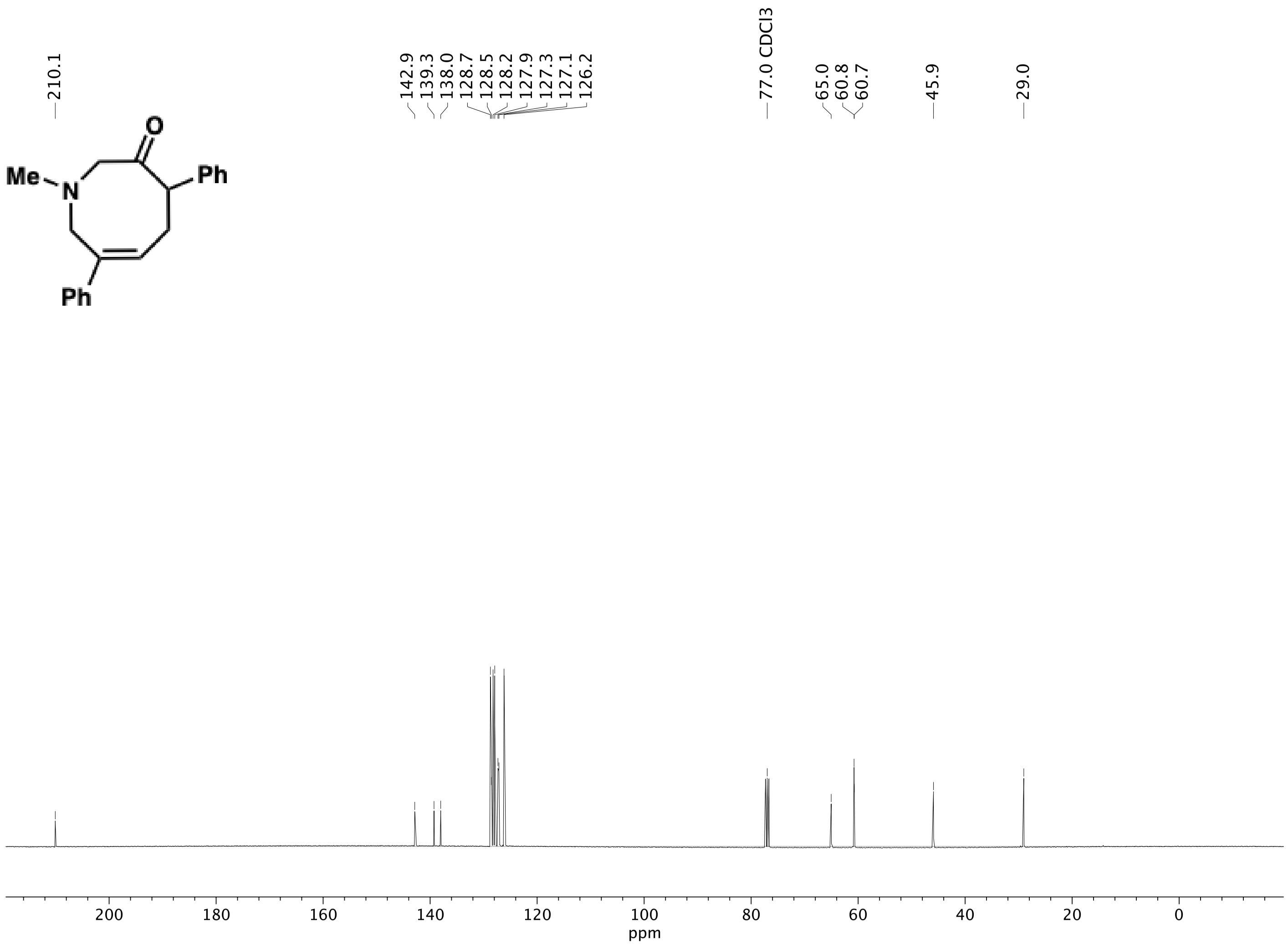
^1H NMR (400 MHz, $CDCl_3$) of compound **3g**.



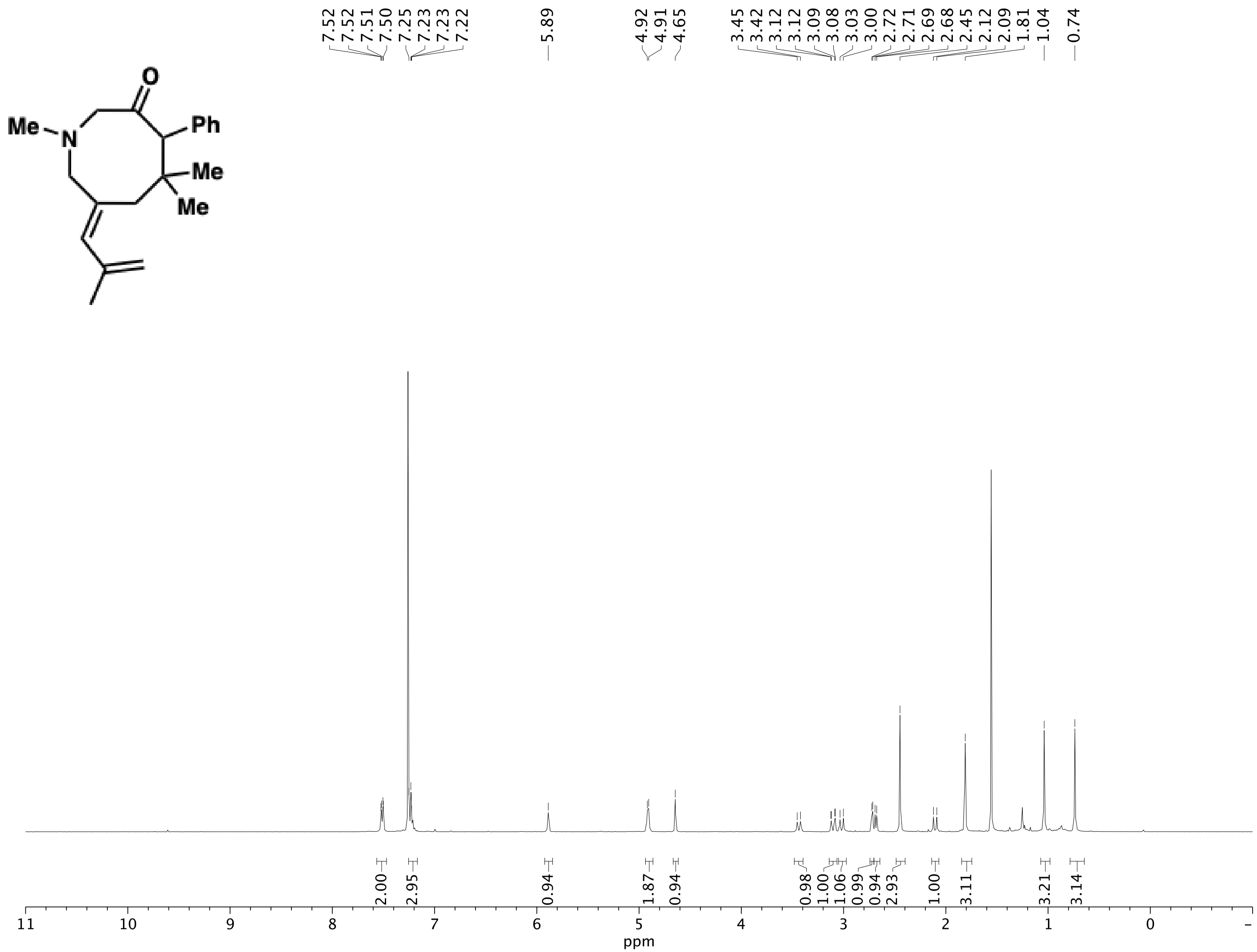
^{13}C NMR (101 MHz, $CDCl_3$) of compound **3g.**



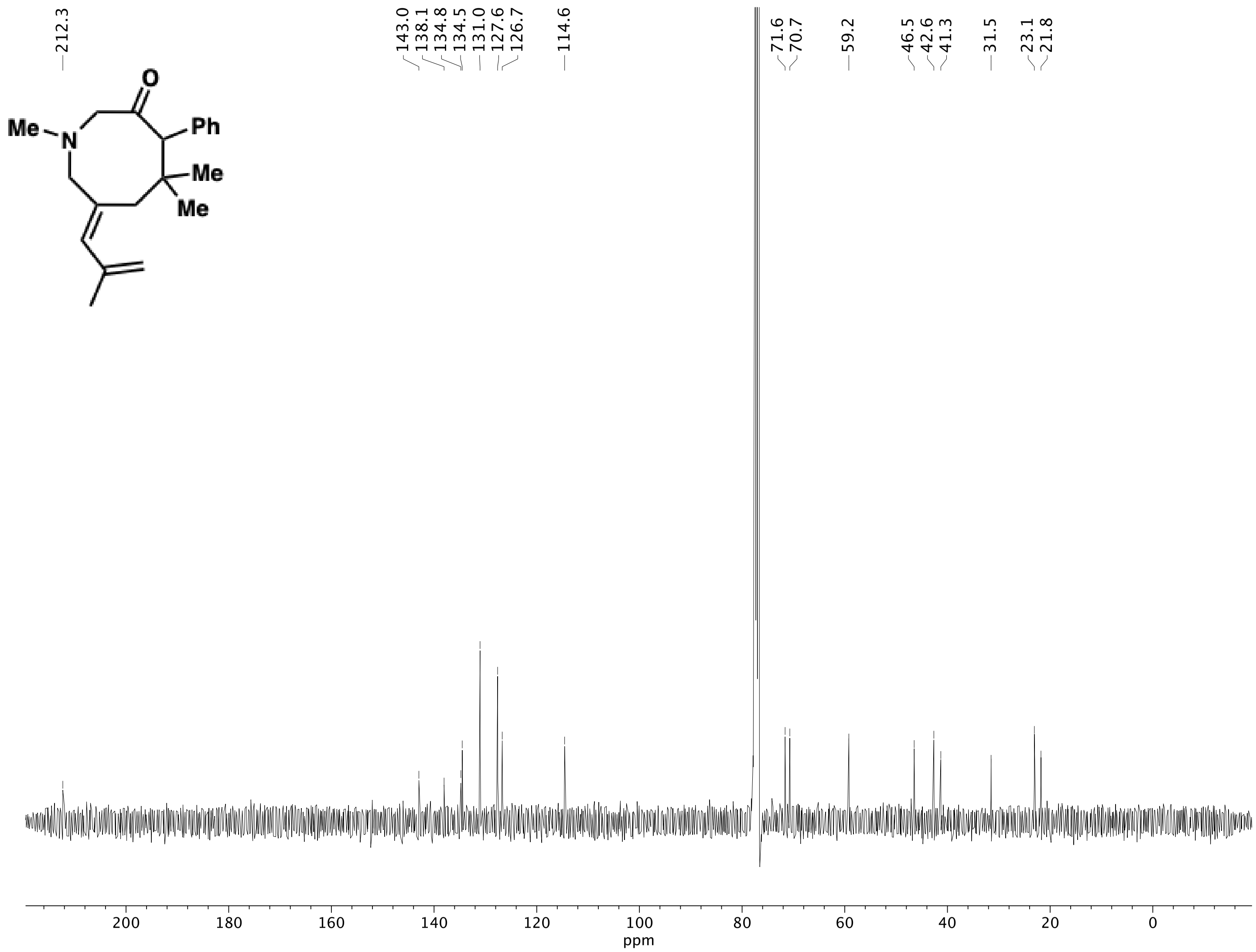
^{1}H NMR (400 MHz, $CDCl_3$) of compound **3h**.



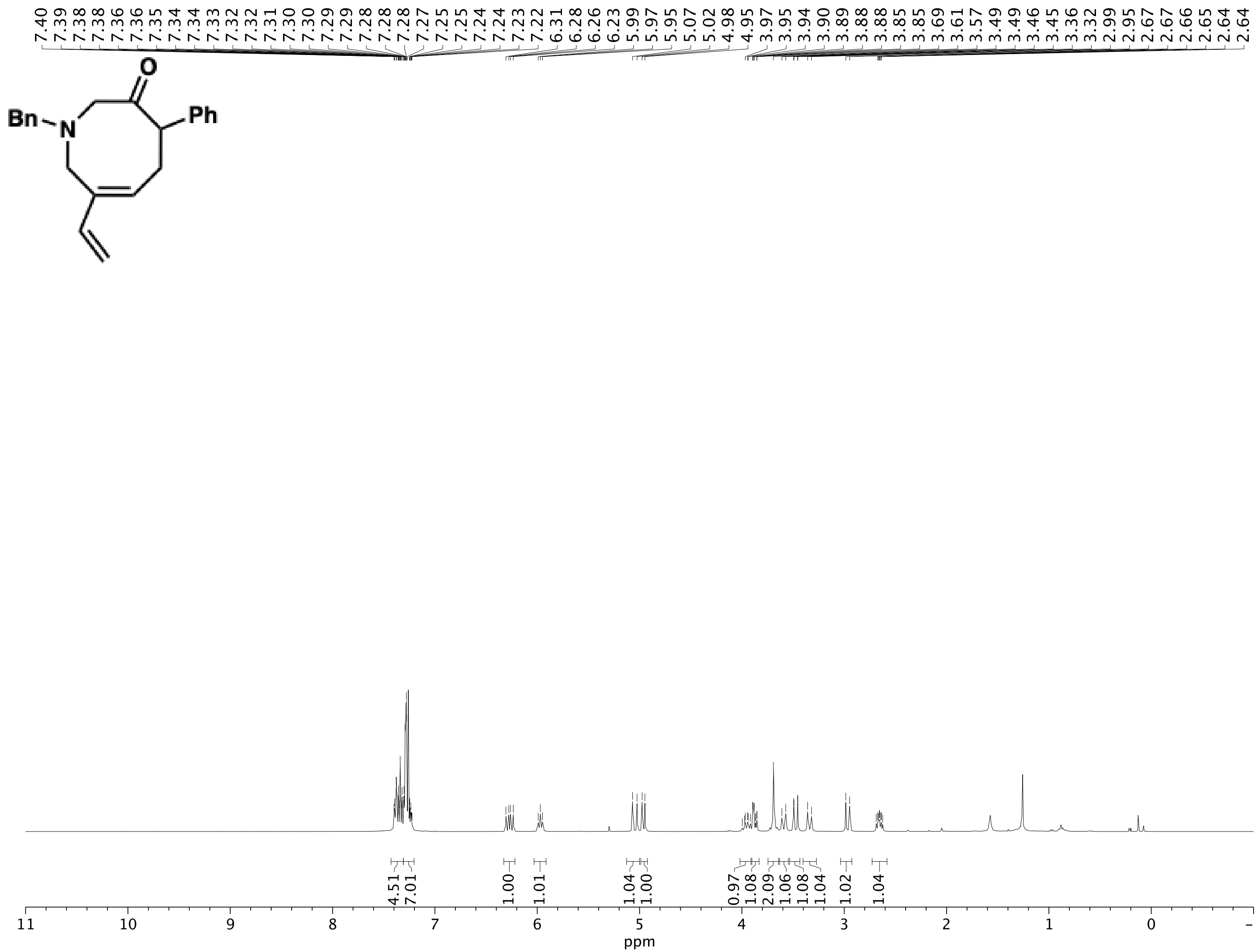
^{13}C NMR (101 MHz, $CDCl_3$) of compound **3h.**



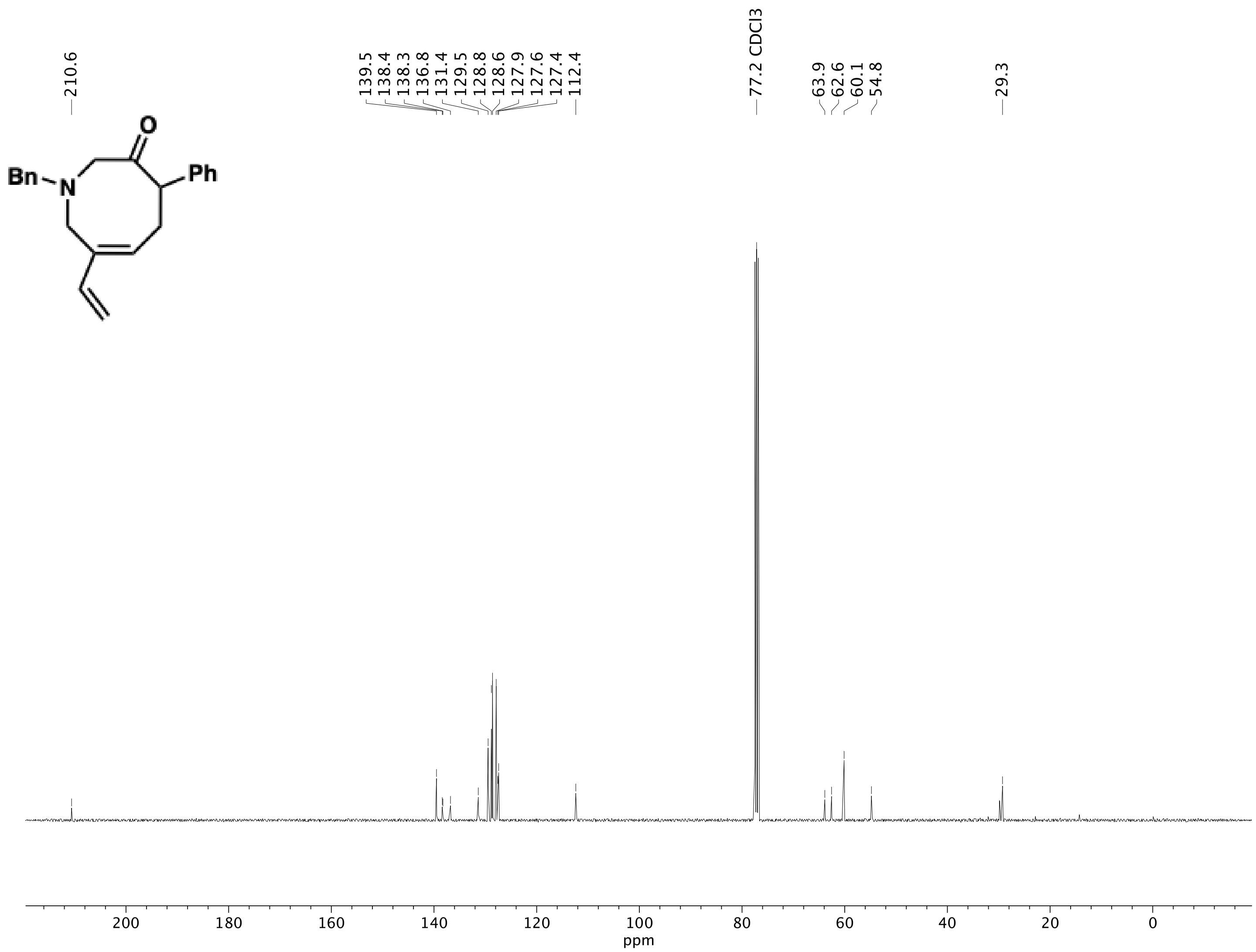
^{1}H NMR (400 MHz, $CDCl_3$) of compound **3i**.



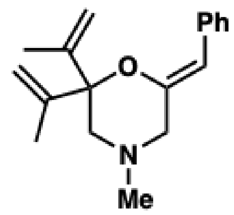
^{13}C NMR (101 MHz, $CDCl_3$) of compound **3i.**

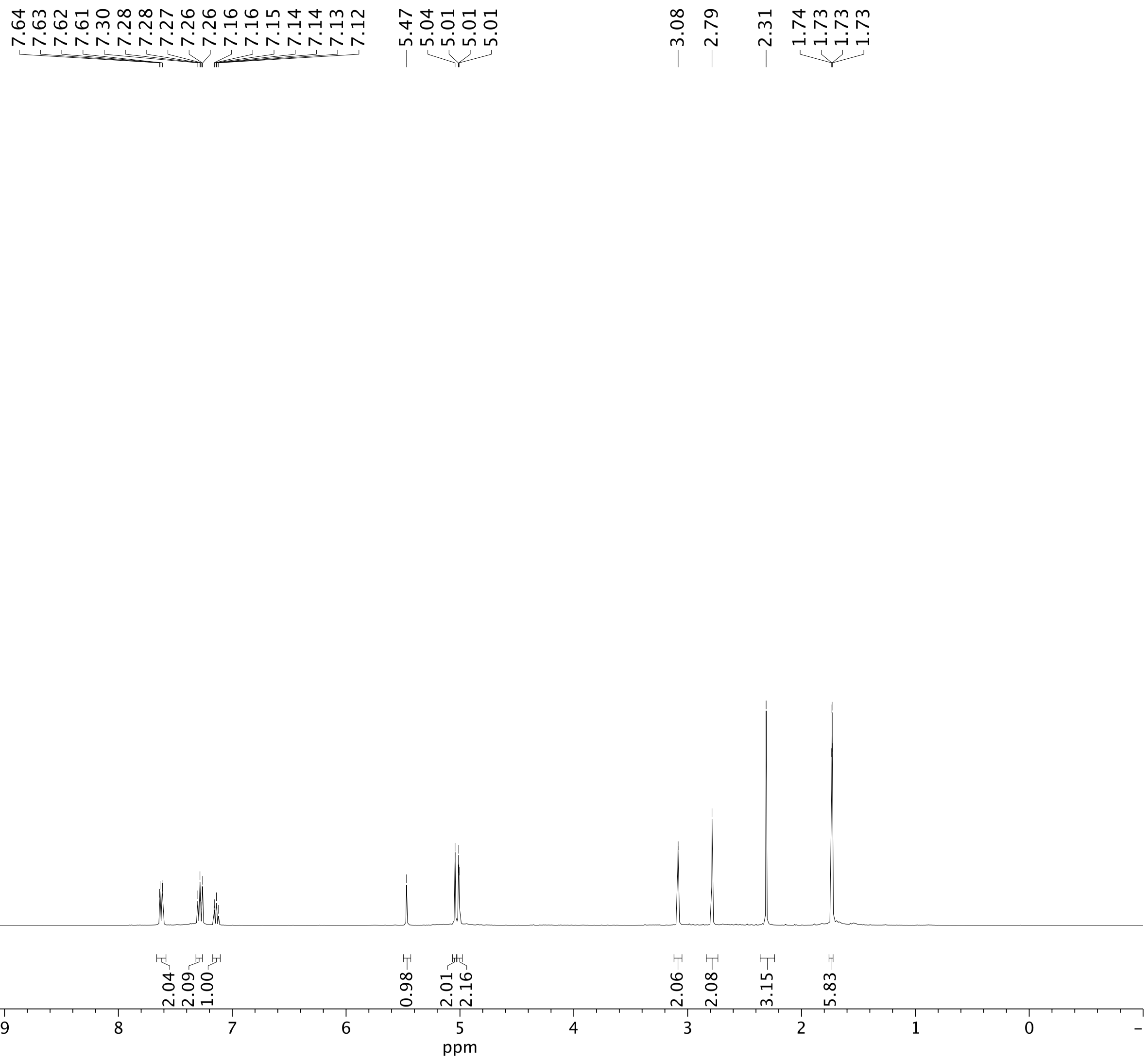


^{1}H NMR (400 MHz, $CDCl_3$) of compound **3j**.

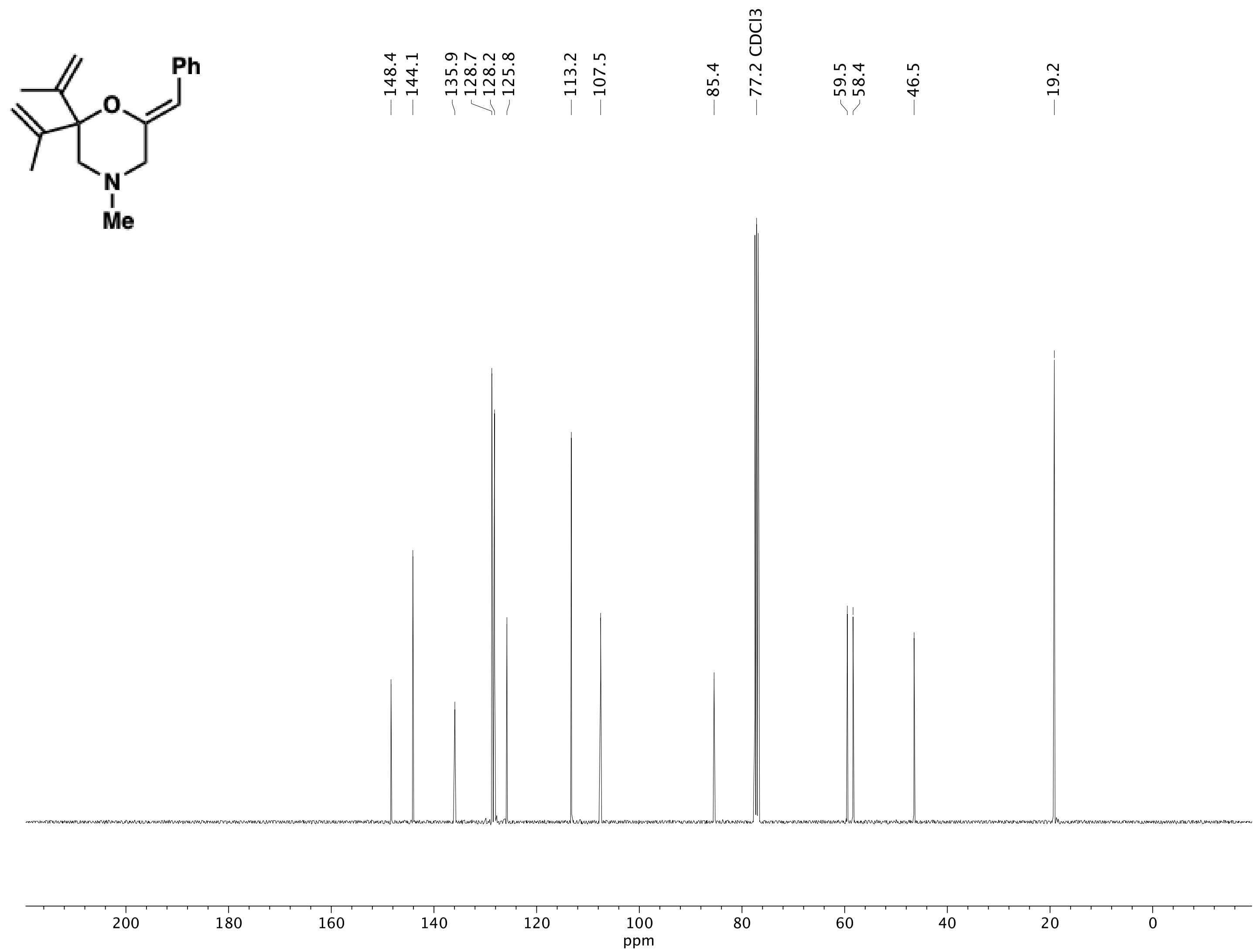


^{13}C NMR (101 MHz, $CDCl_3$) of compound **3j.**

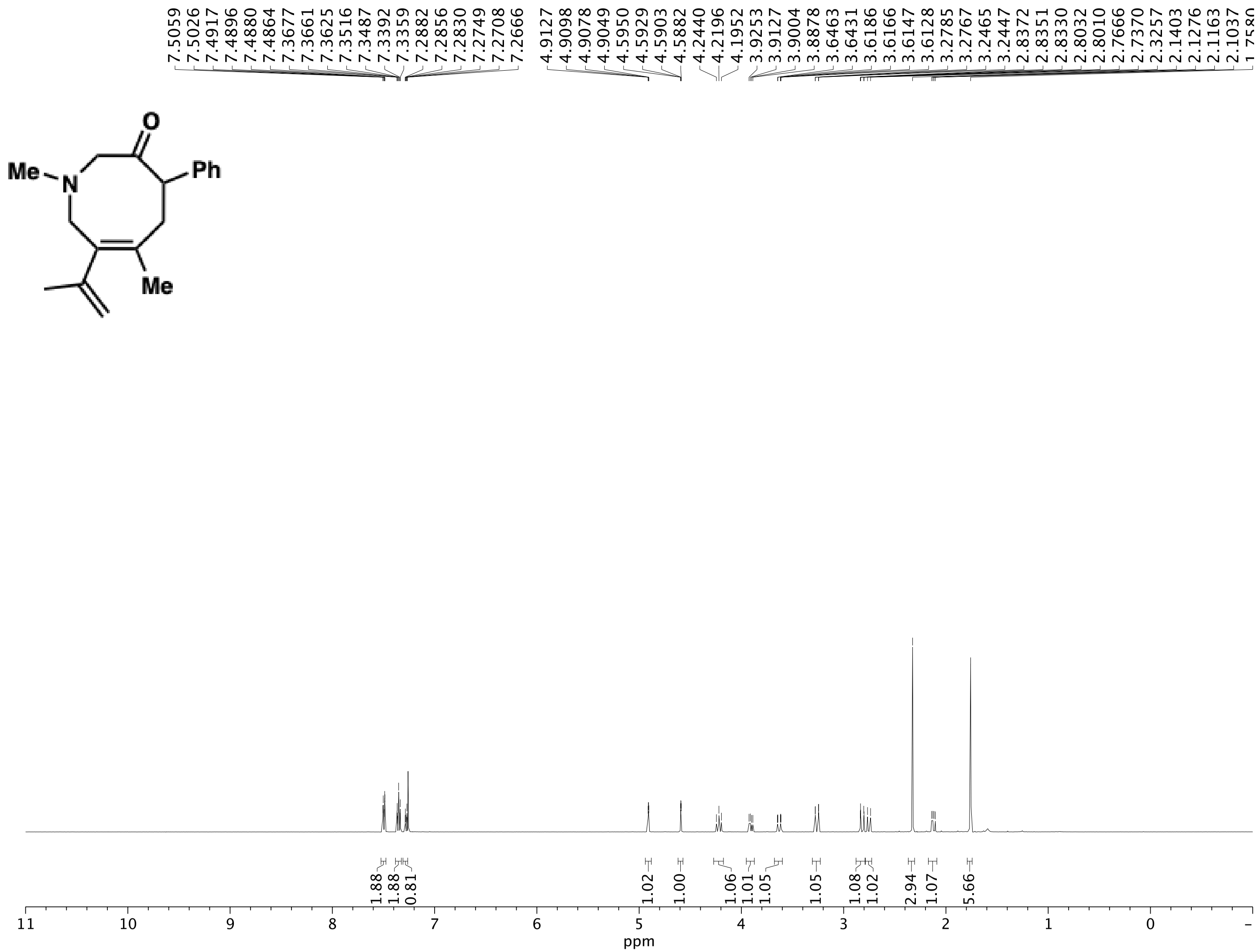




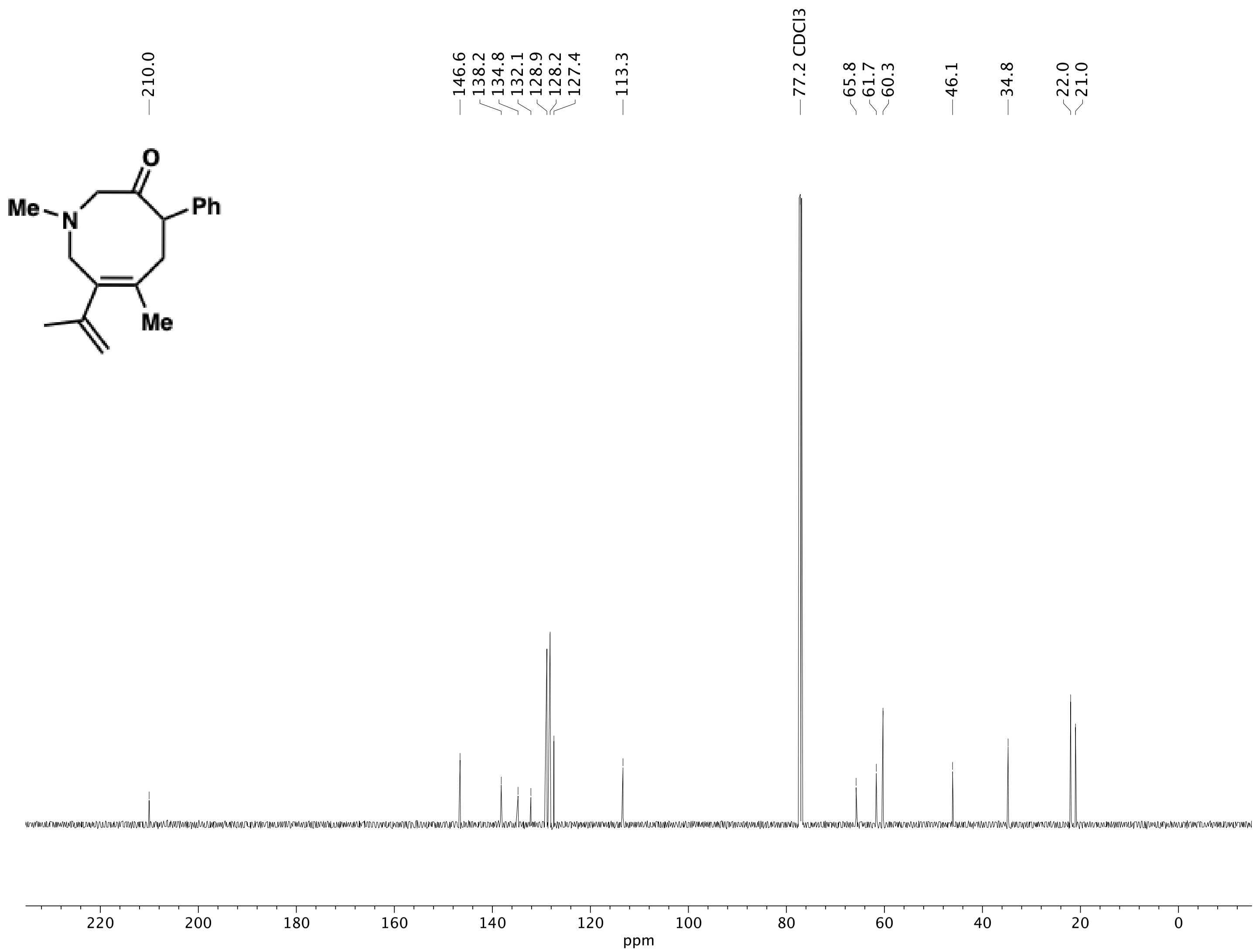
^1H NMR (400 MHz, $CDCl_3$) of compound **2k**.



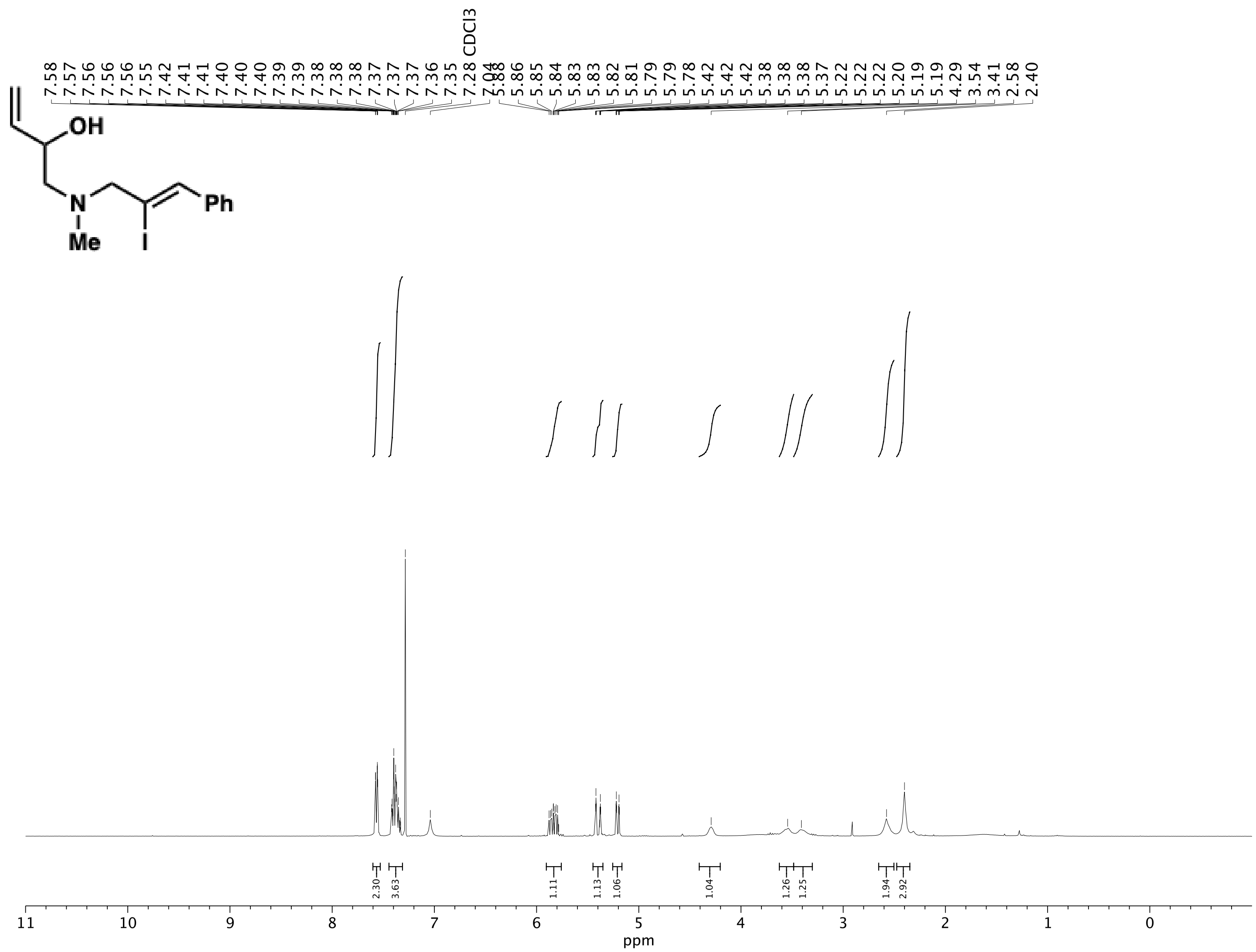
^{13}C NMR (101 MHz, $CDCl_3$) of compound **2k.**



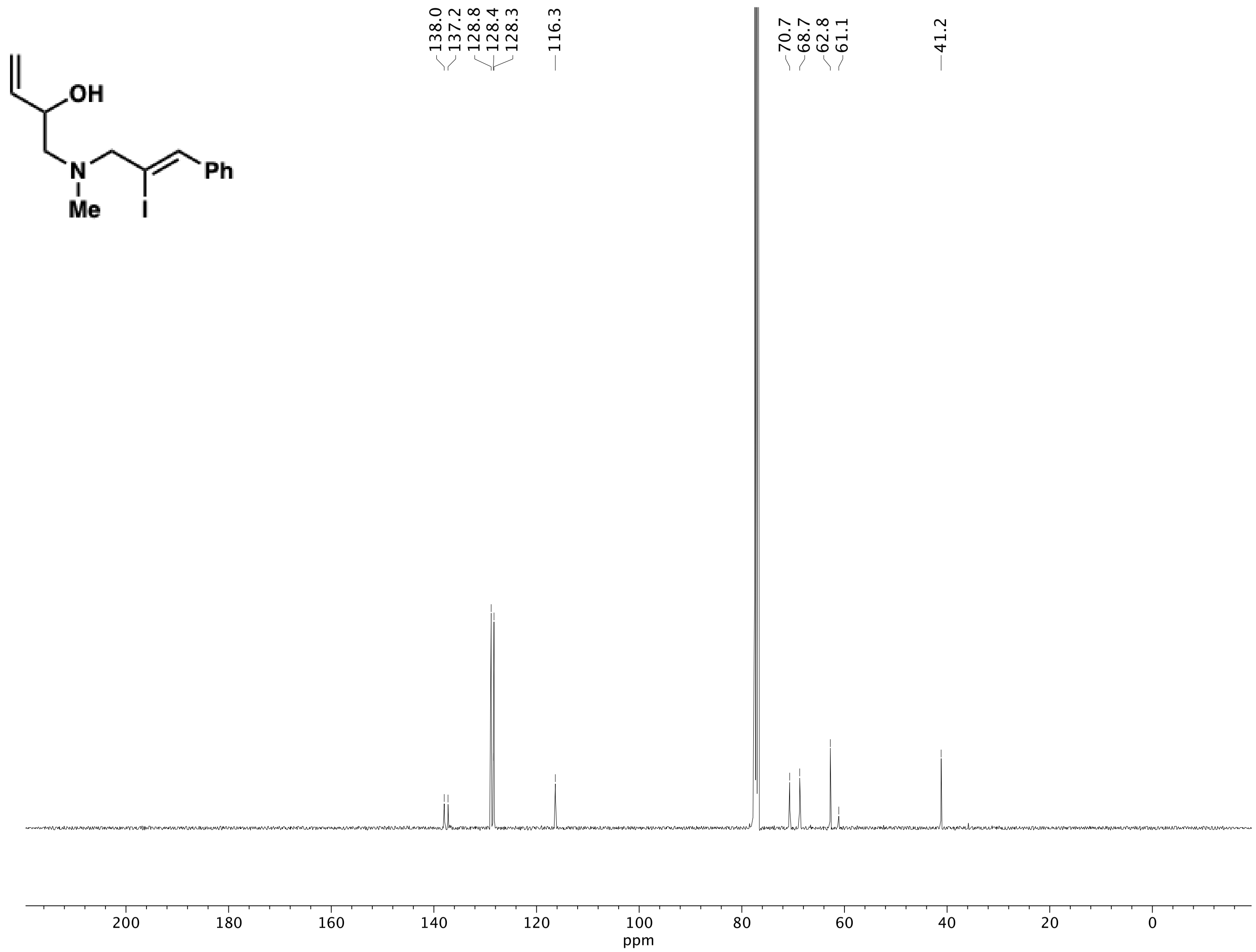
^{1}H NMR (500 MHz, $CDCl_3$) of compound **3k**.



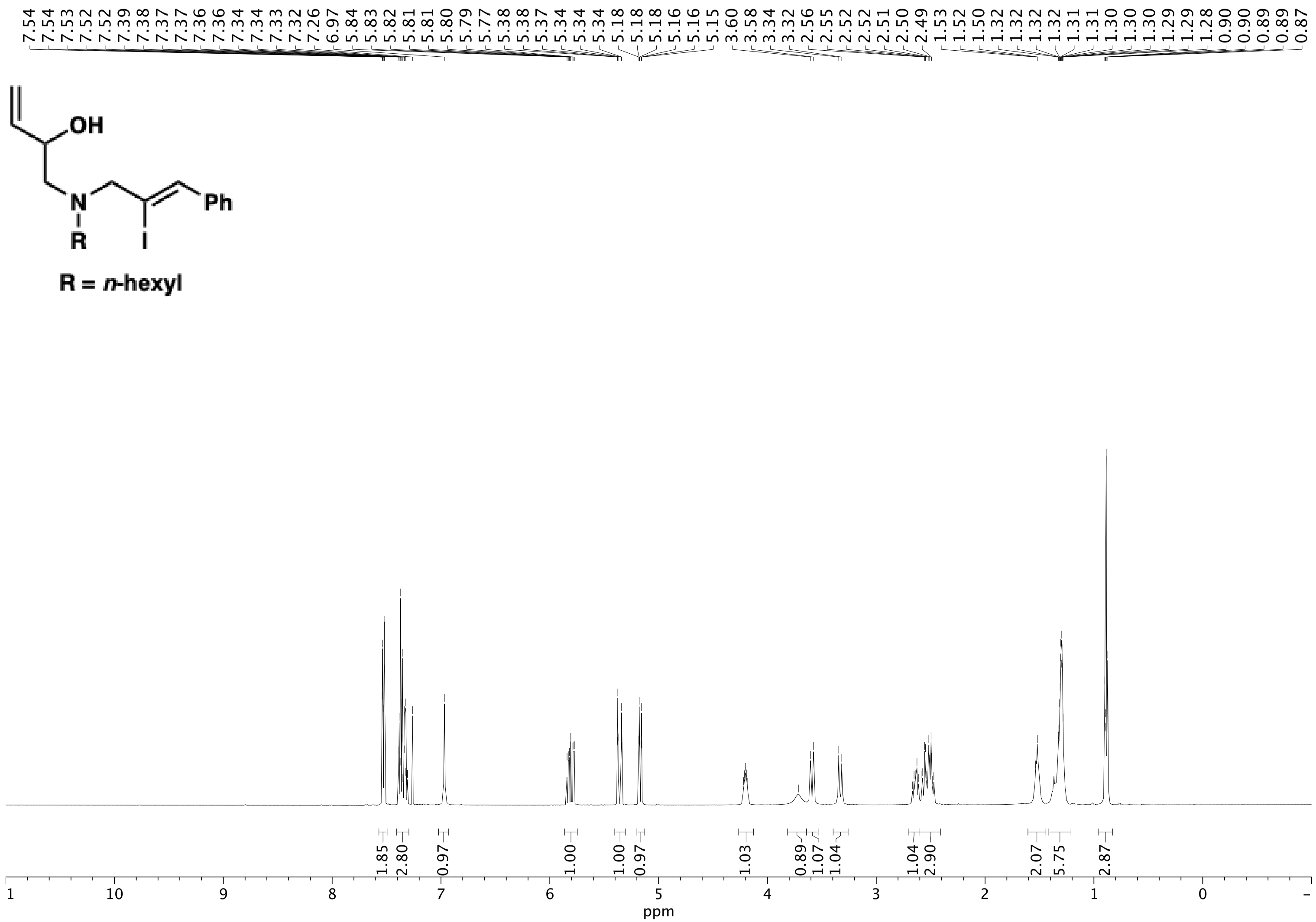
^{13}C NMR (126 MHz, $CDCl_3$) of compound **3k.**



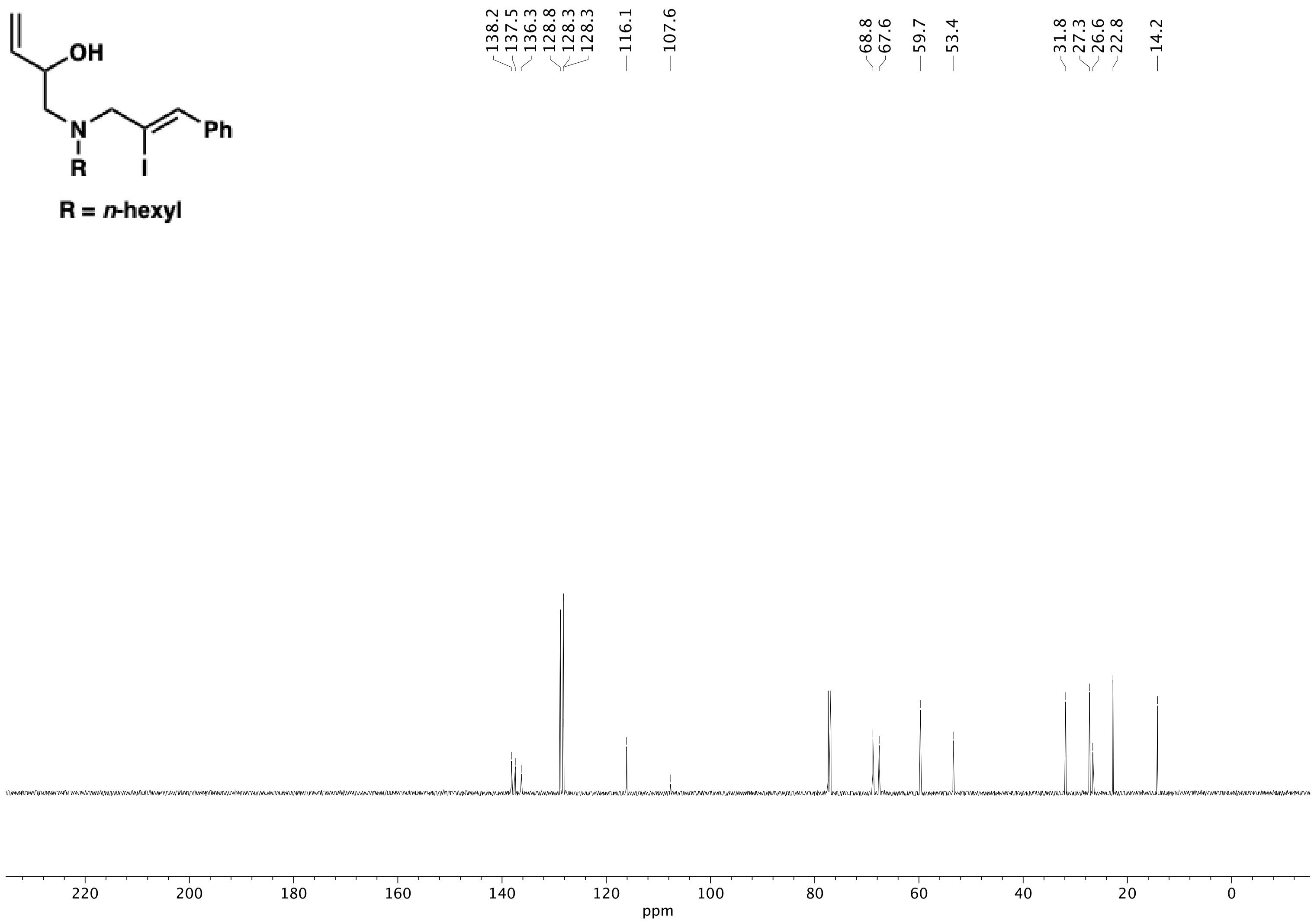
^{1}H NMR (400 MHz, $CDCl_3$) of compound **1l**.



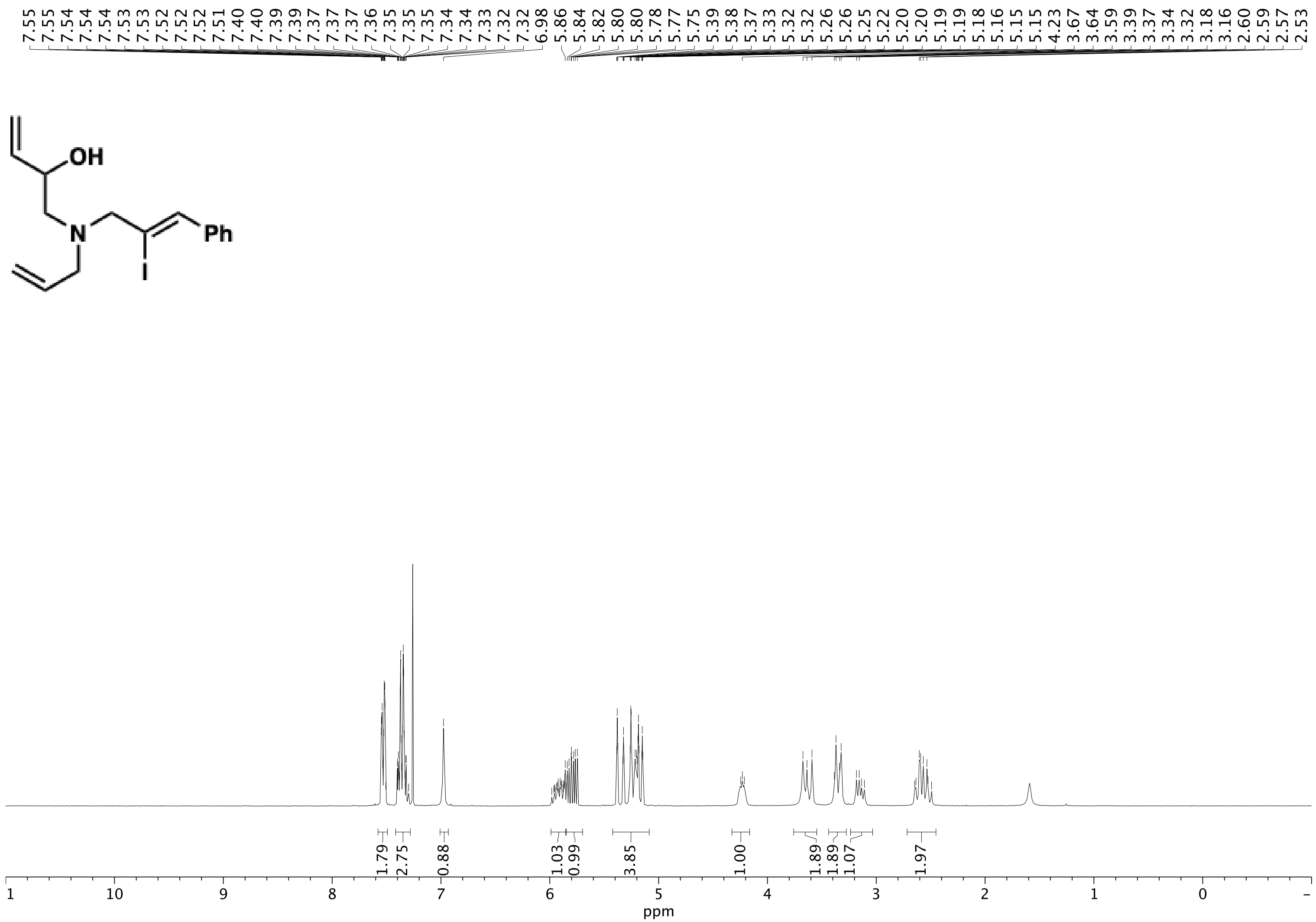
^{13}C NMR (101 MHz, $CDCl_3$) of compound **1l**.



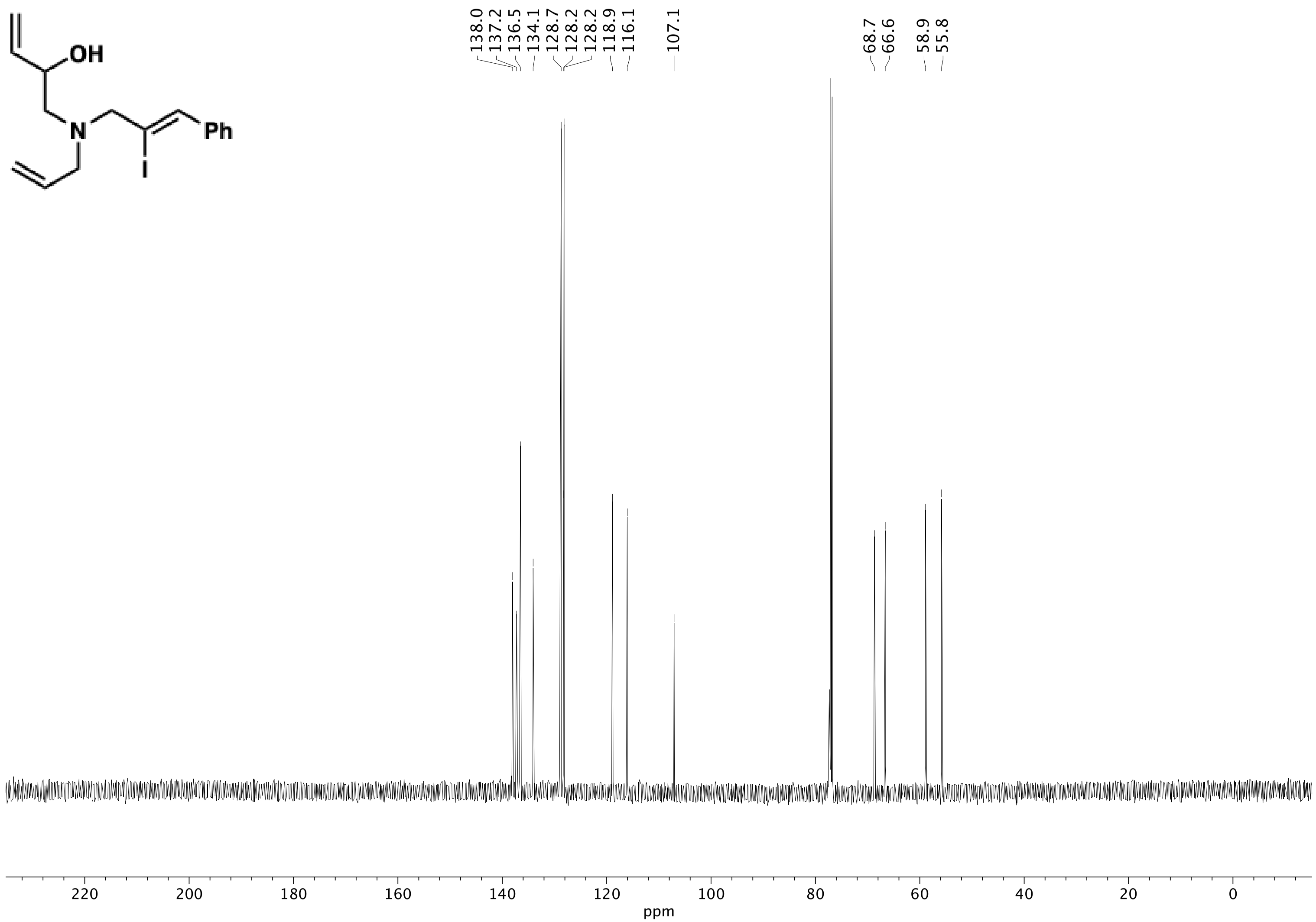
^{1}H NMR (500 MHz, $CDCl_3$) of compound **1n**.



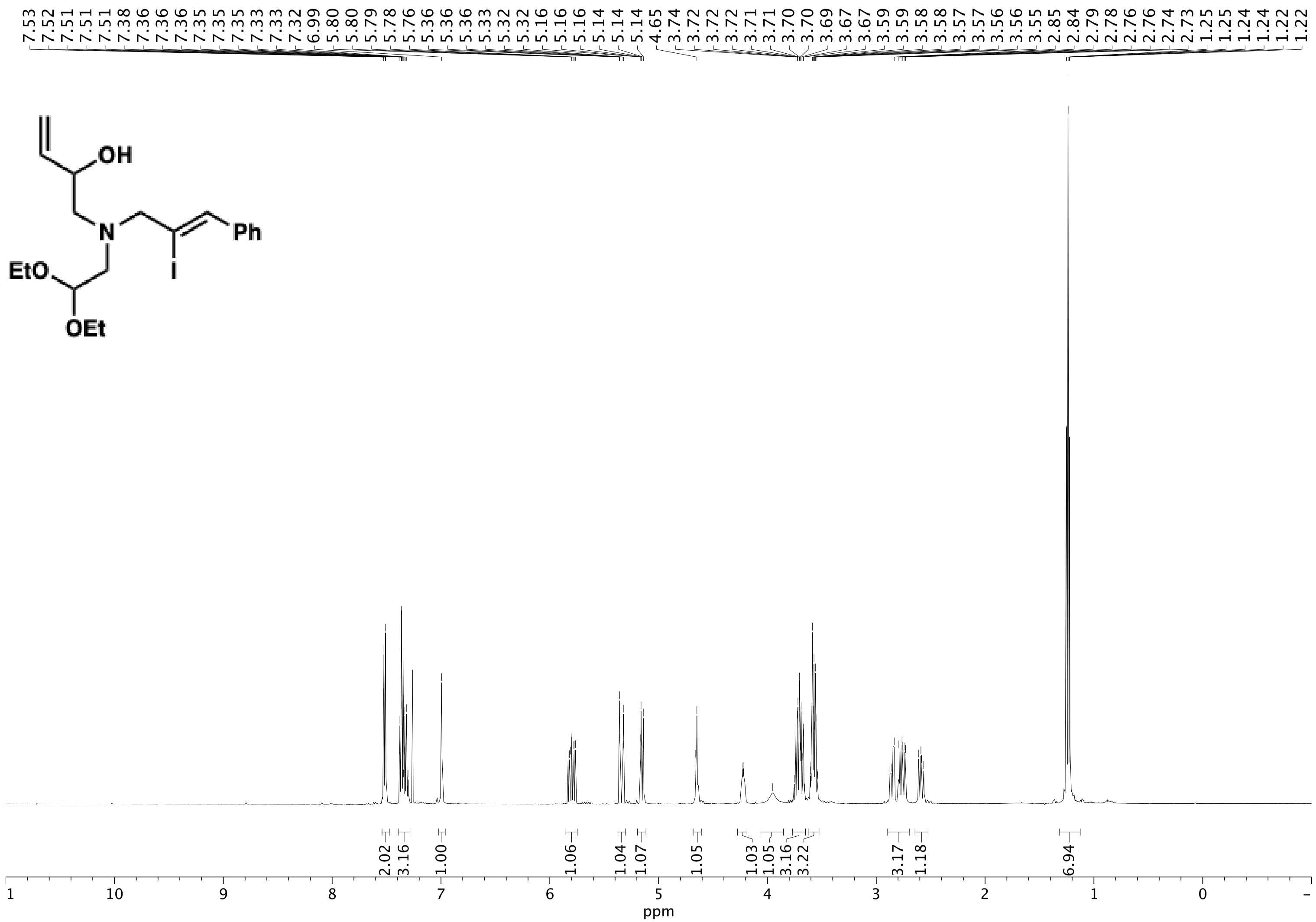
^{13}C NMR (126 MHz, $CDCl_3$) of compound **1n**.



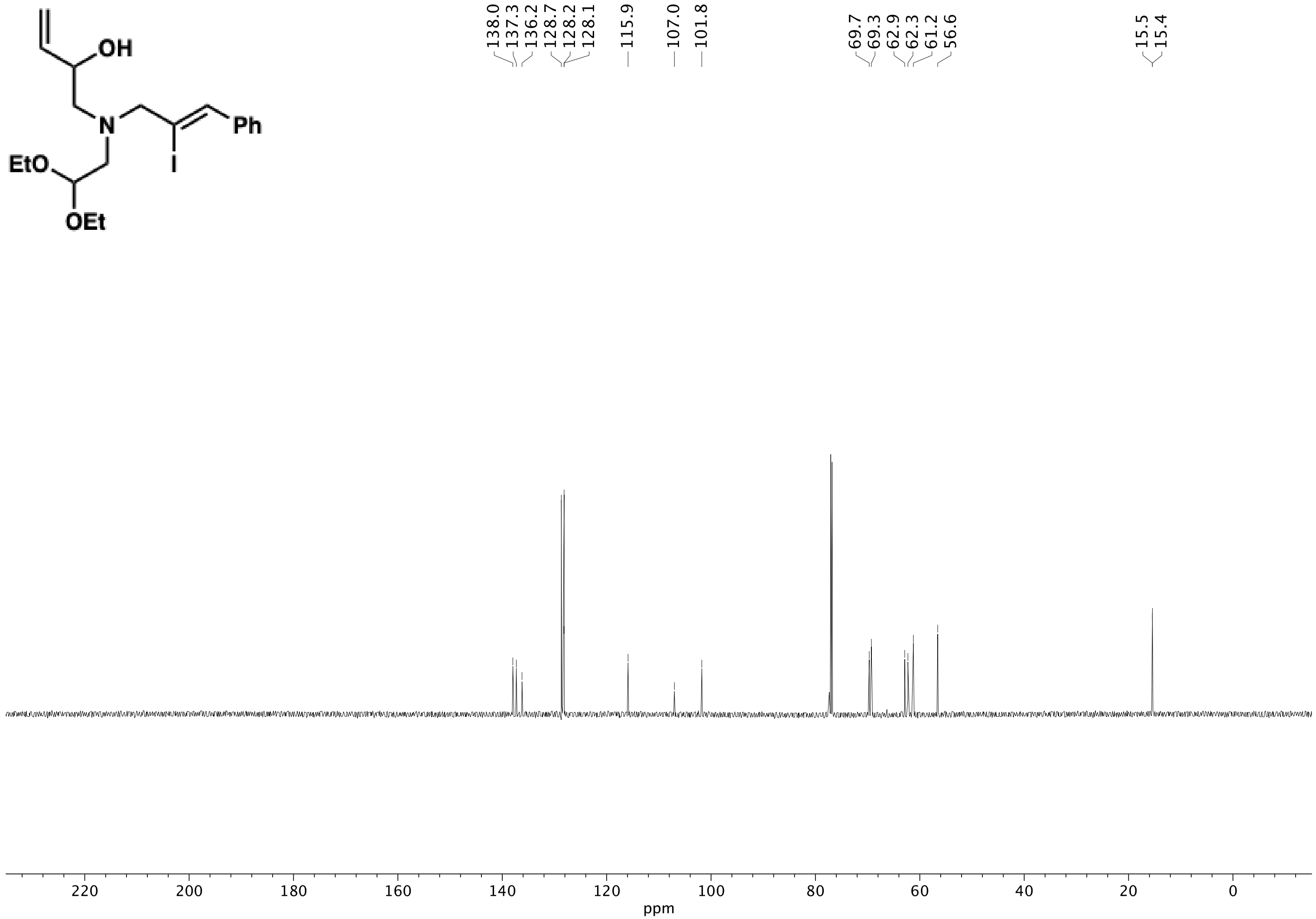
[1]H NMR (300 MHz, $CDCl_3$) of compound **1o**.



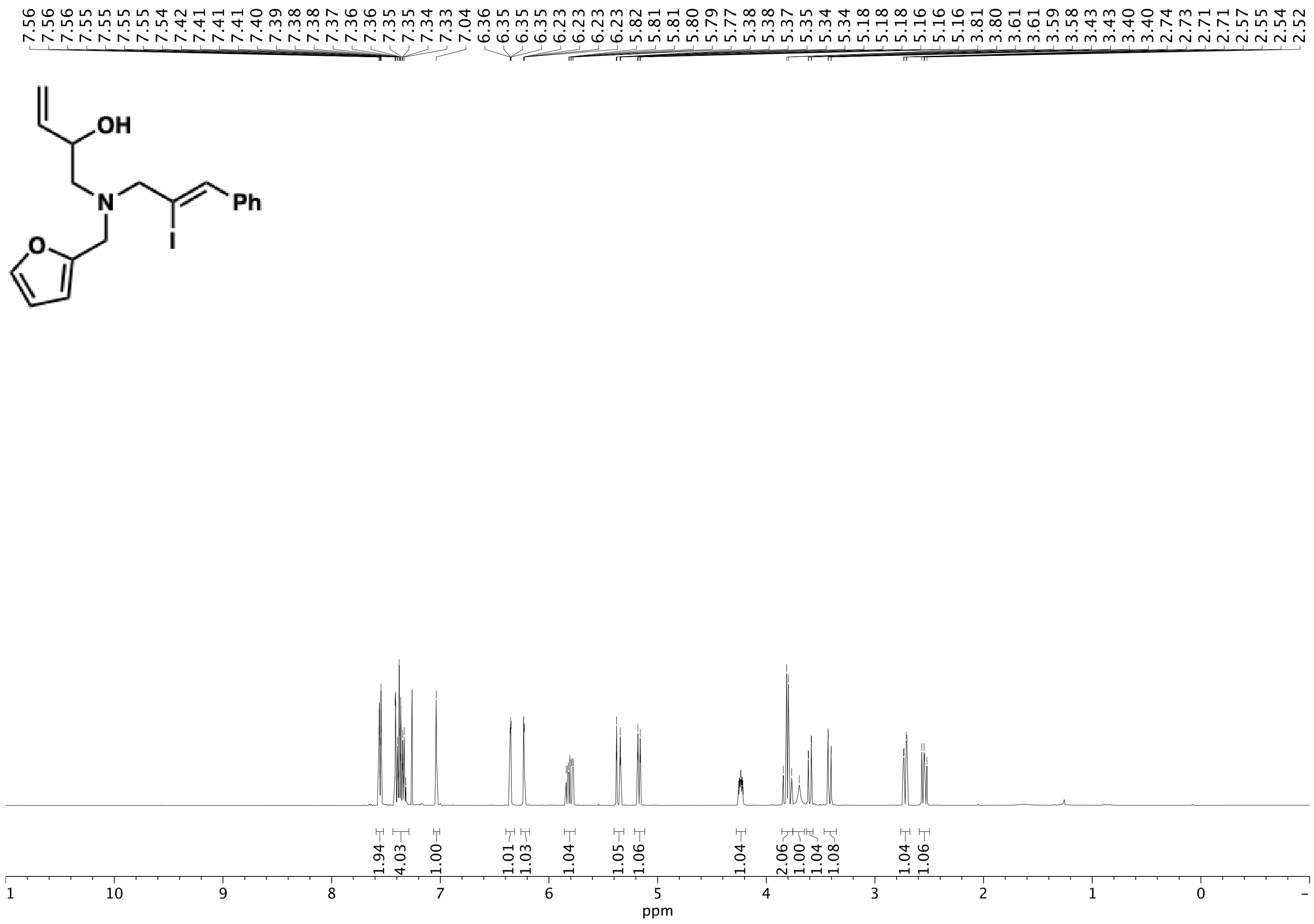
^{13}C NMR (126 MHz, $CDCl_3$) of compound **1o**.



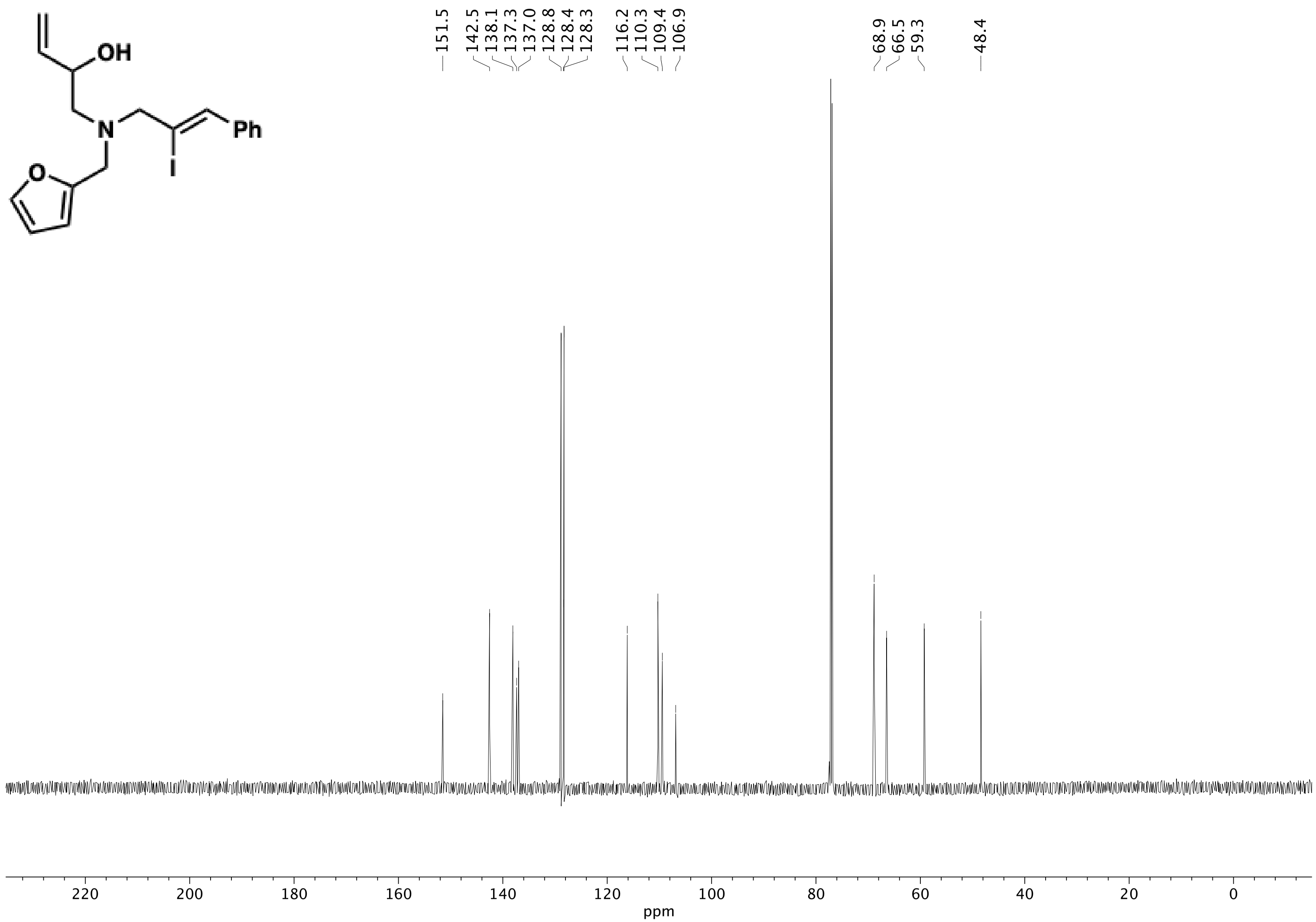
[1]H NMR (500 MHz, $CDCl_3$) of compound **1p**.



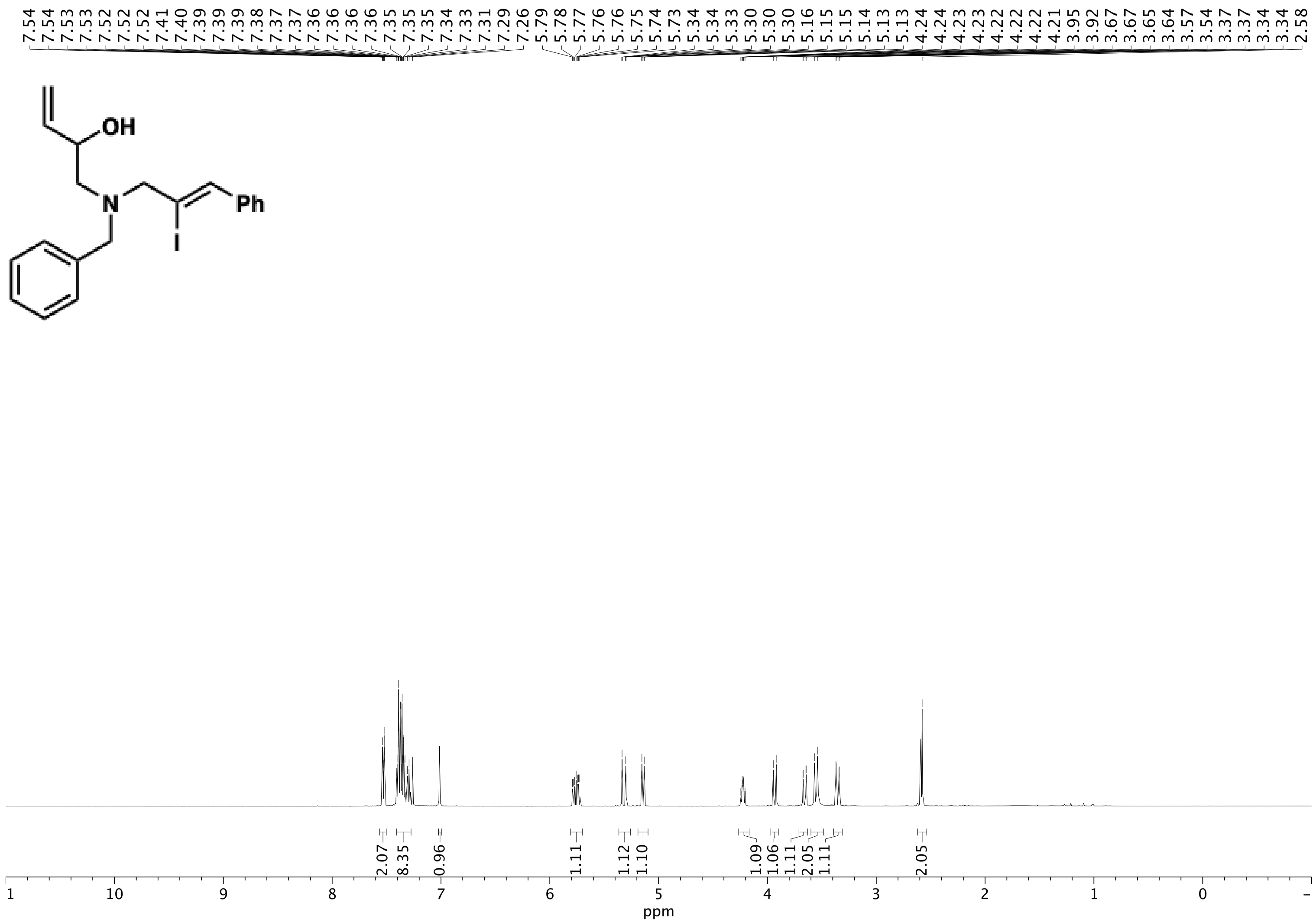
^{13}C NMR (126 MHz, $CDCl_3$) of compound **1p**.



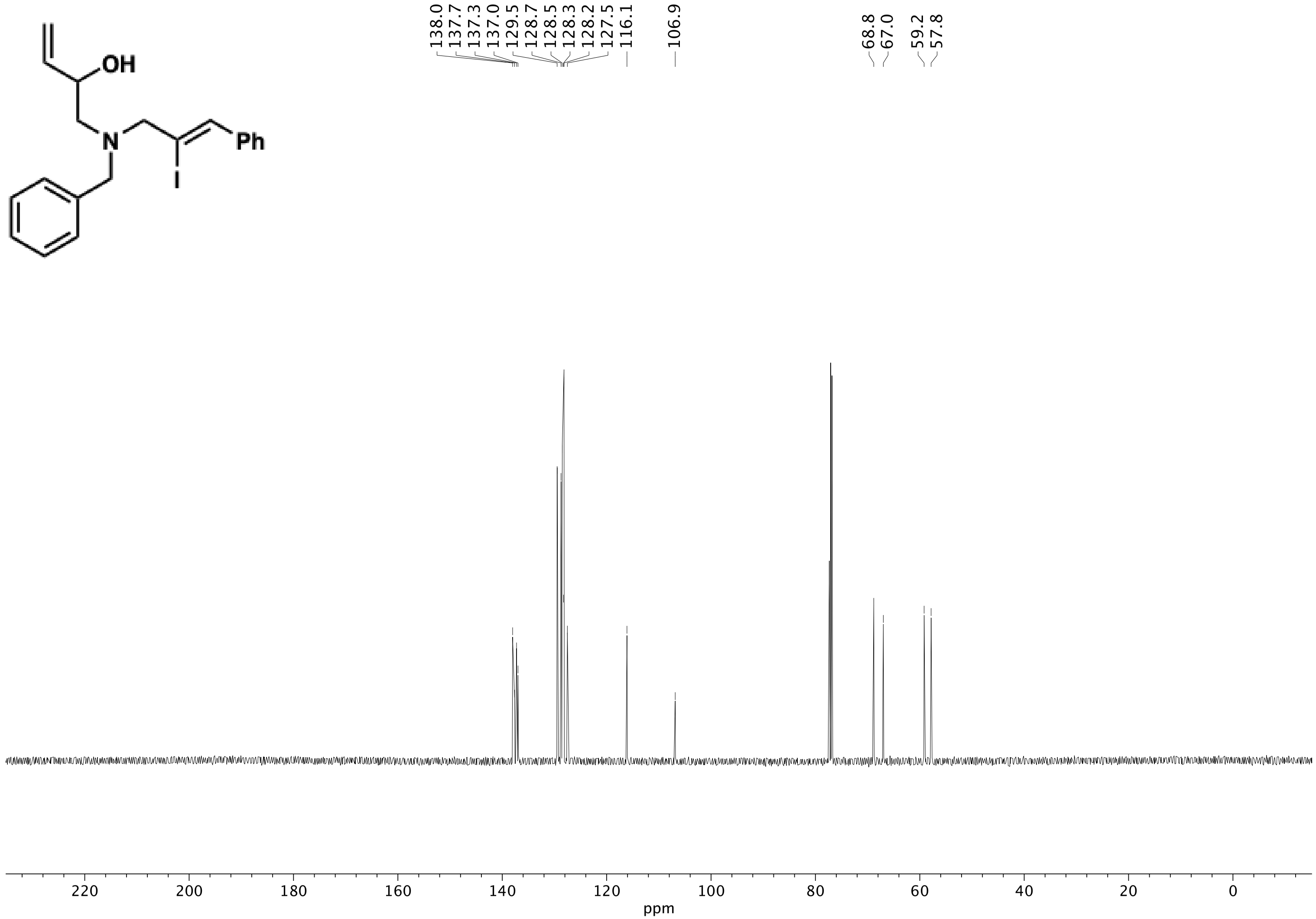
^{1}H NMR (500 MHz, $CDCl_3$) of compound **1q**.



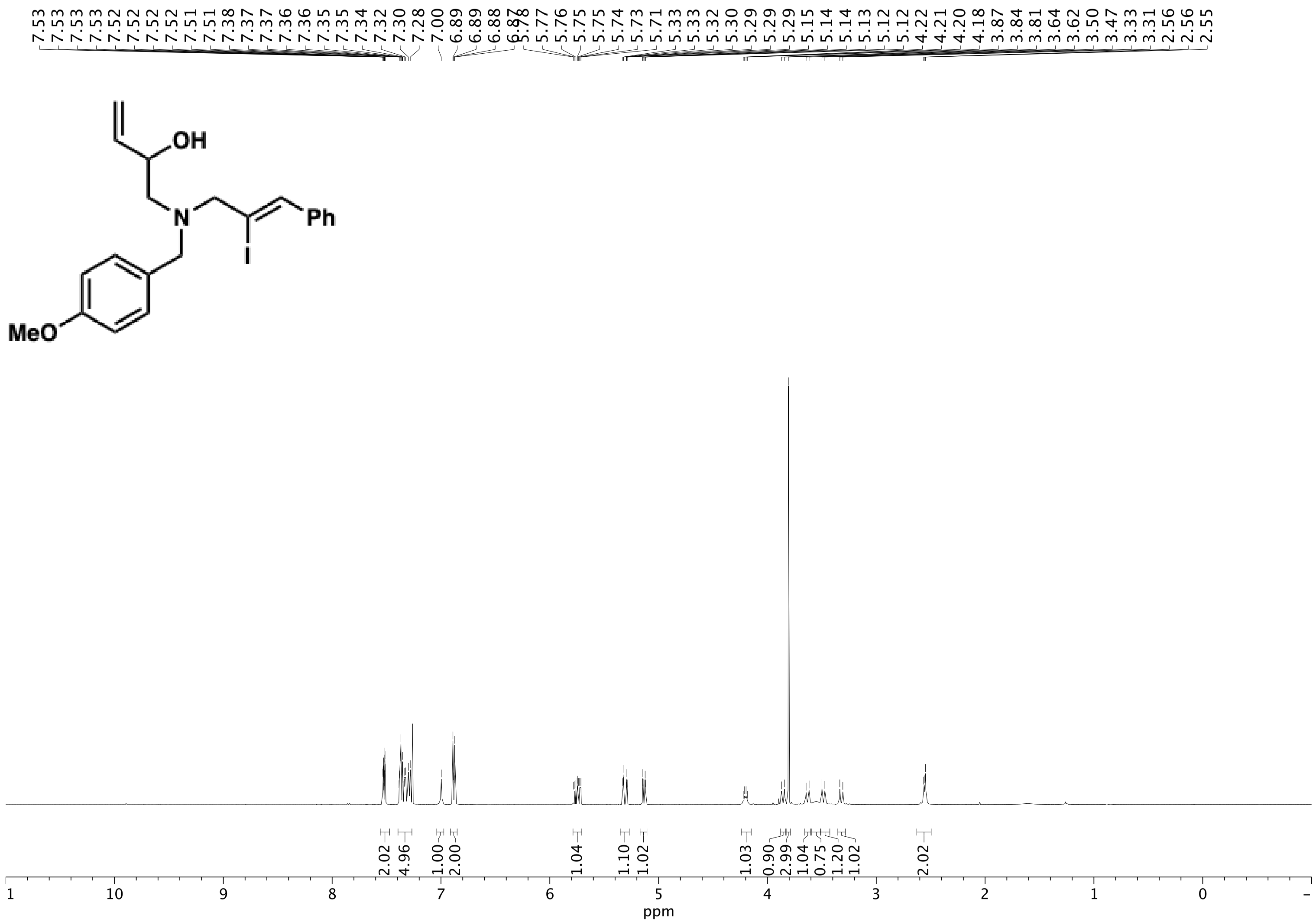
^{13}C NMR (126 MHz, $CDCl_3$) of compound **1q**.



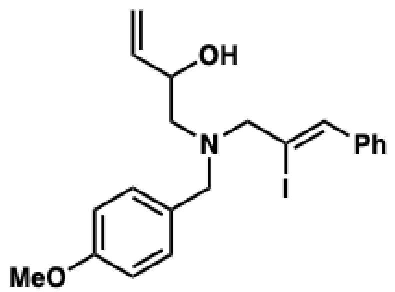
^{1}H NMR (500 MHz, $CDCl_3$) of compound **1r**.

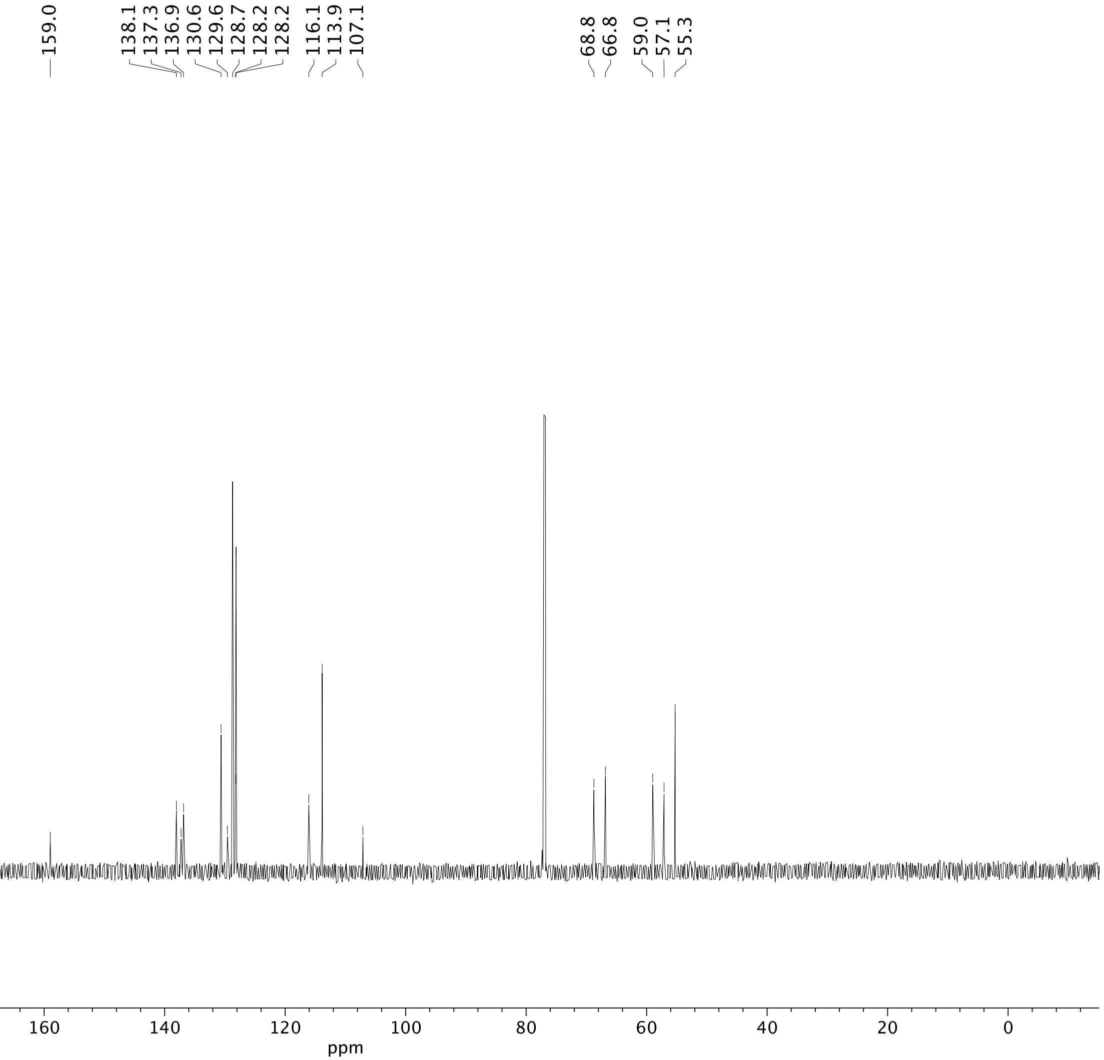


^{13}C NMR (126 MHz, $CDCl_3$) of compound **1r**.

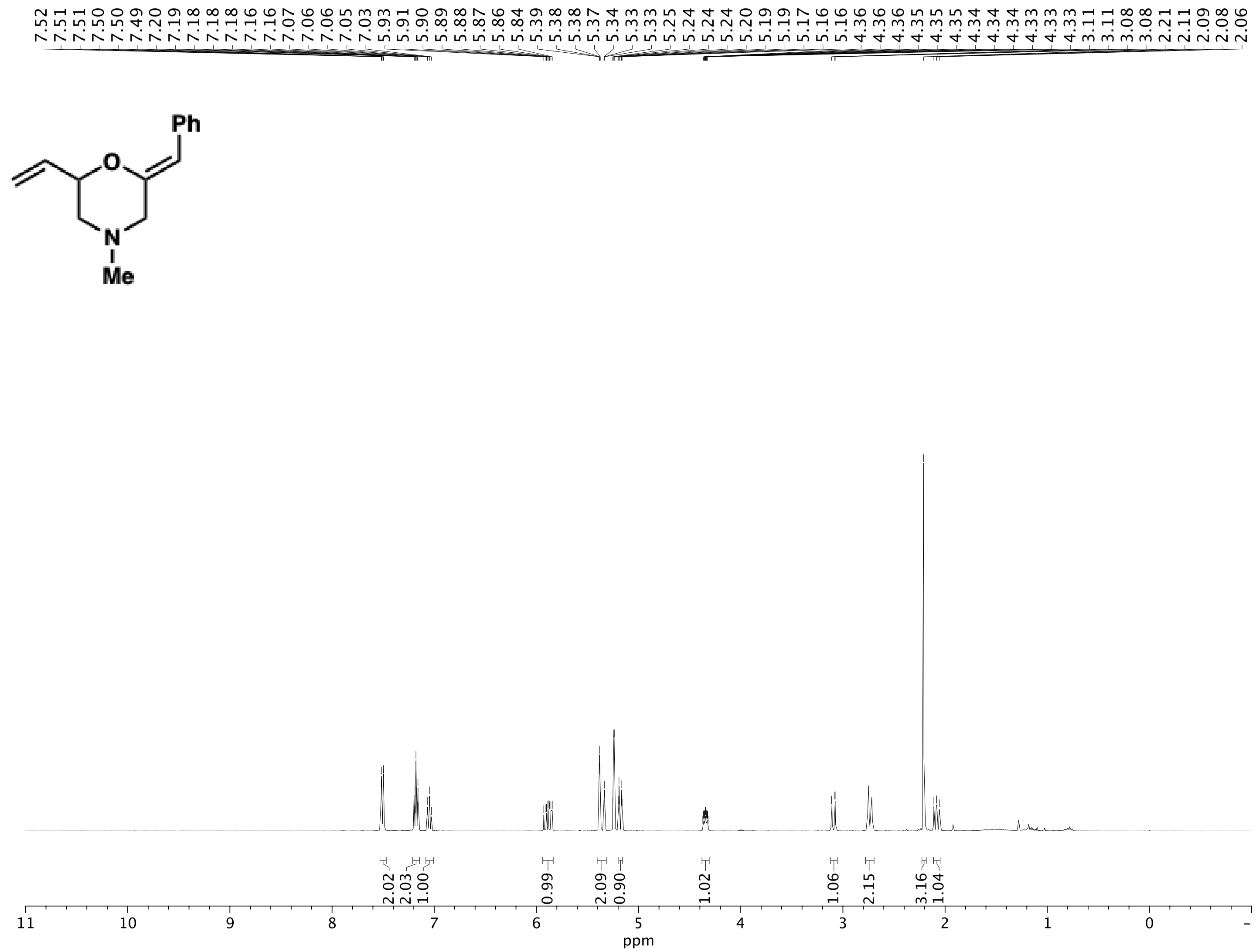


^{1}H NMR (500 MHz, $CDCl_3$) of compound **1s**.

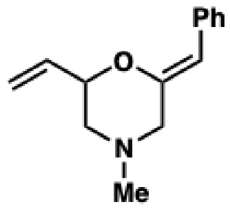


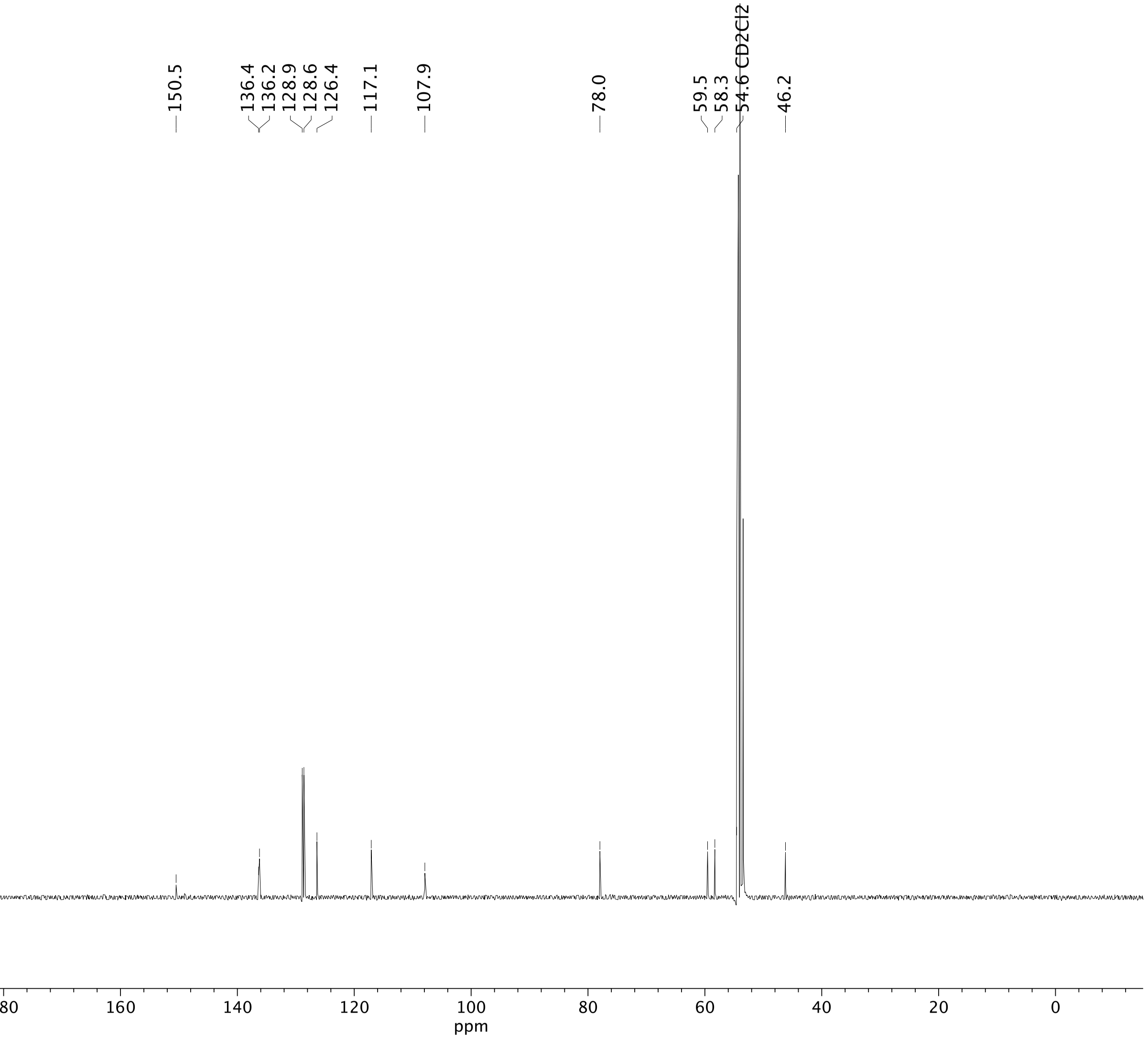


^{13}C NMR (126 MHz, $CDCl_3$) of compound **1s**.

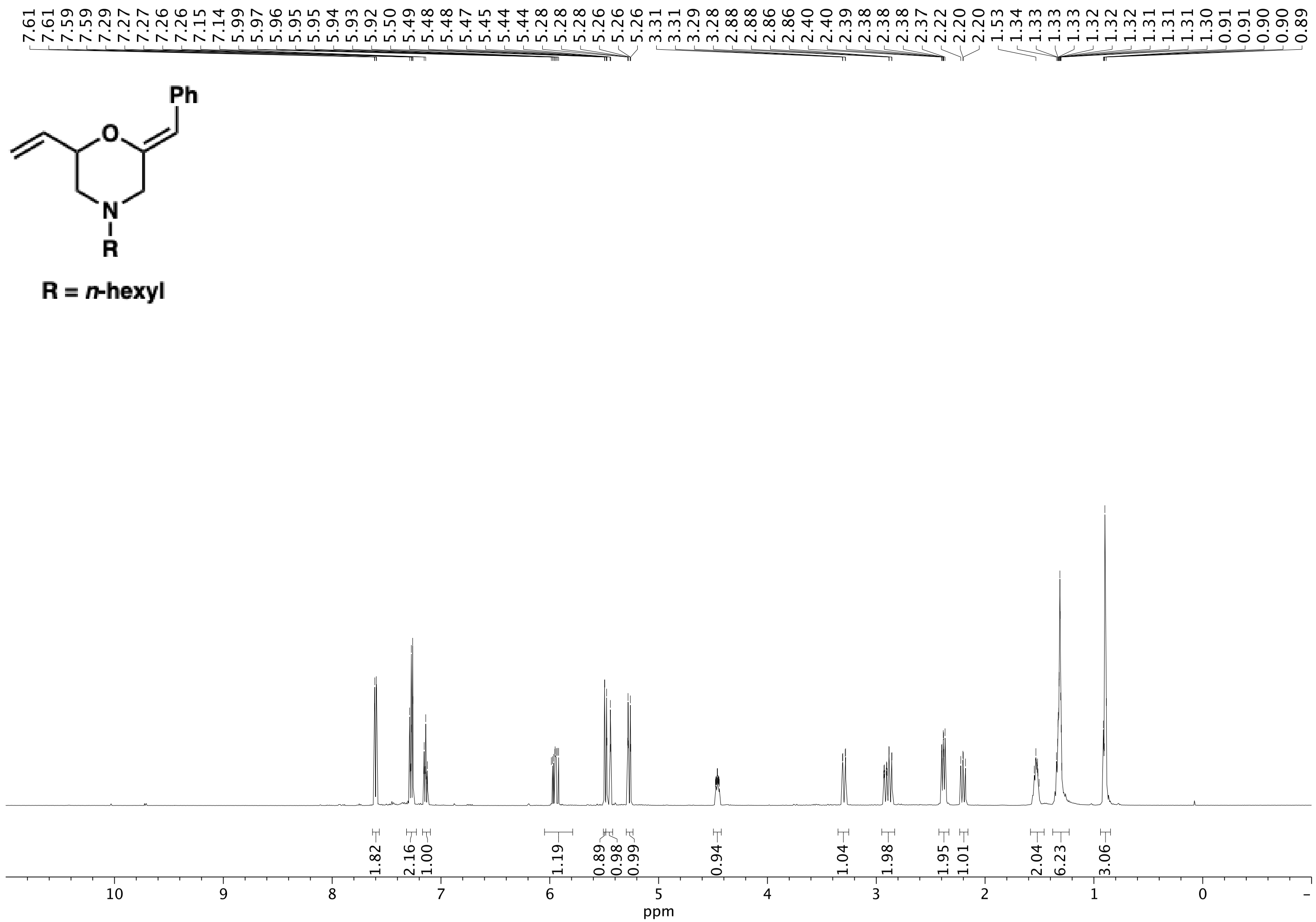


^{1}H NMR (400 MHz, CD_2Cl_2) of compound **2l**.

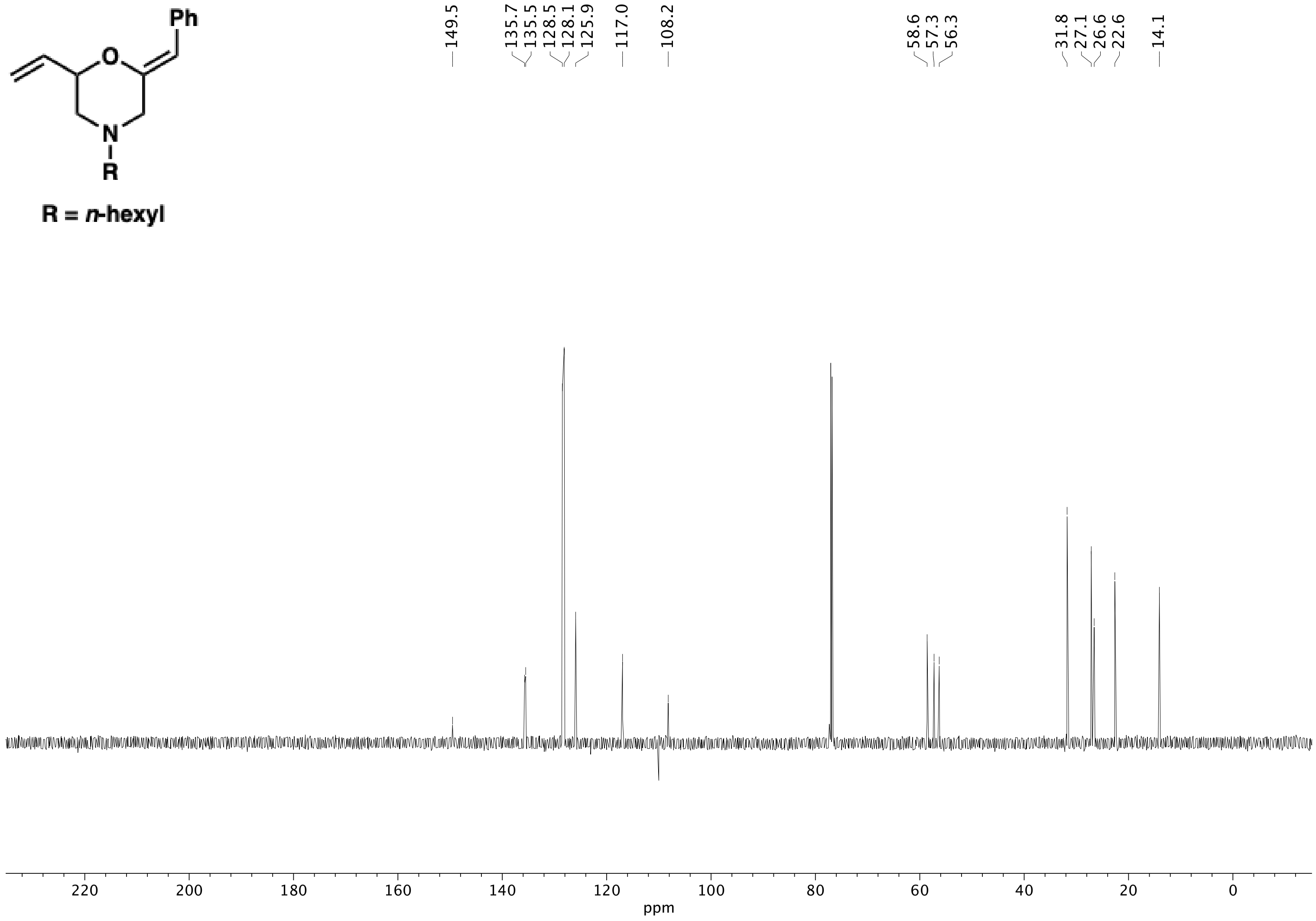




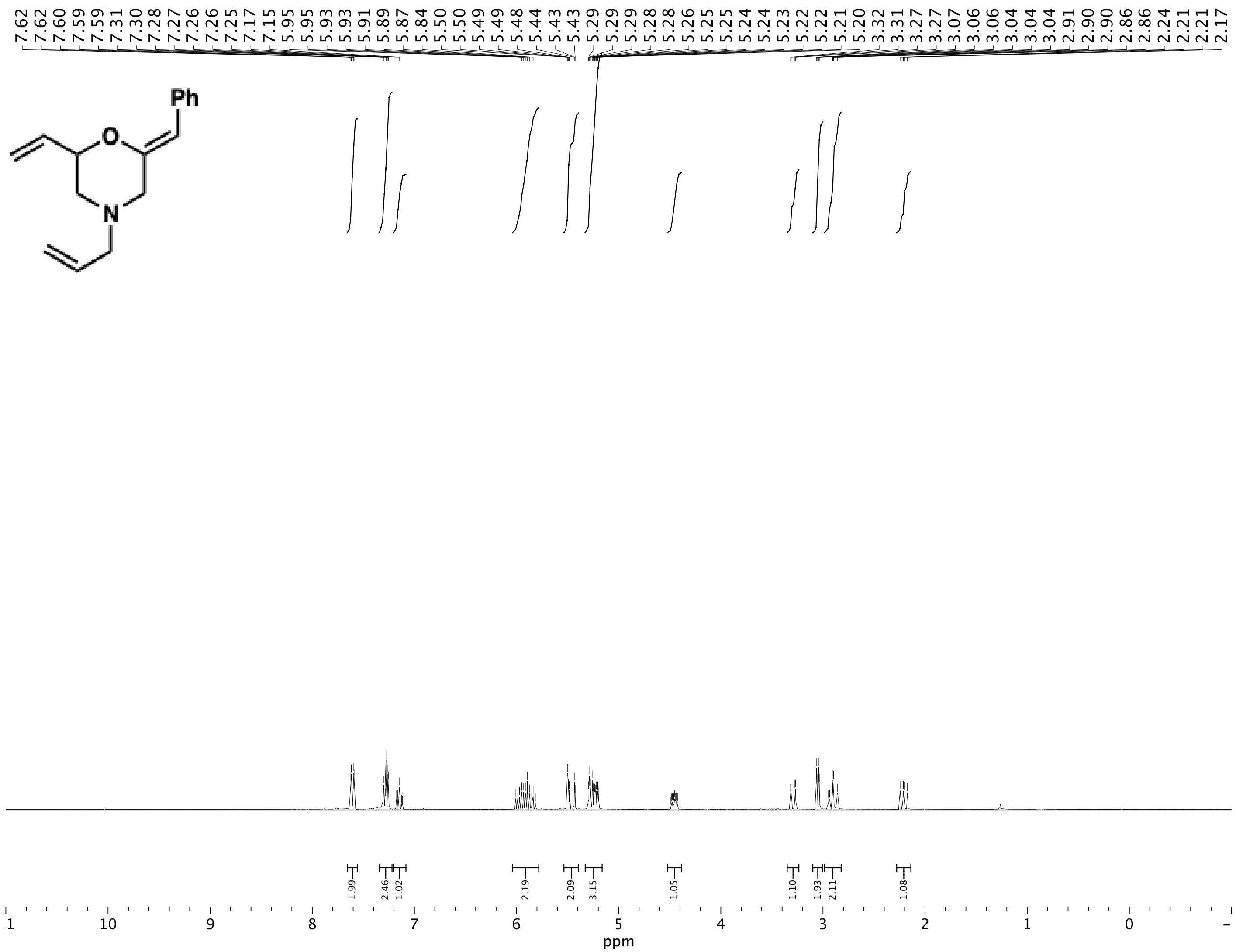
^{13}C NMR (101 MHz, CD_2Cl_2) of compound **2l**.



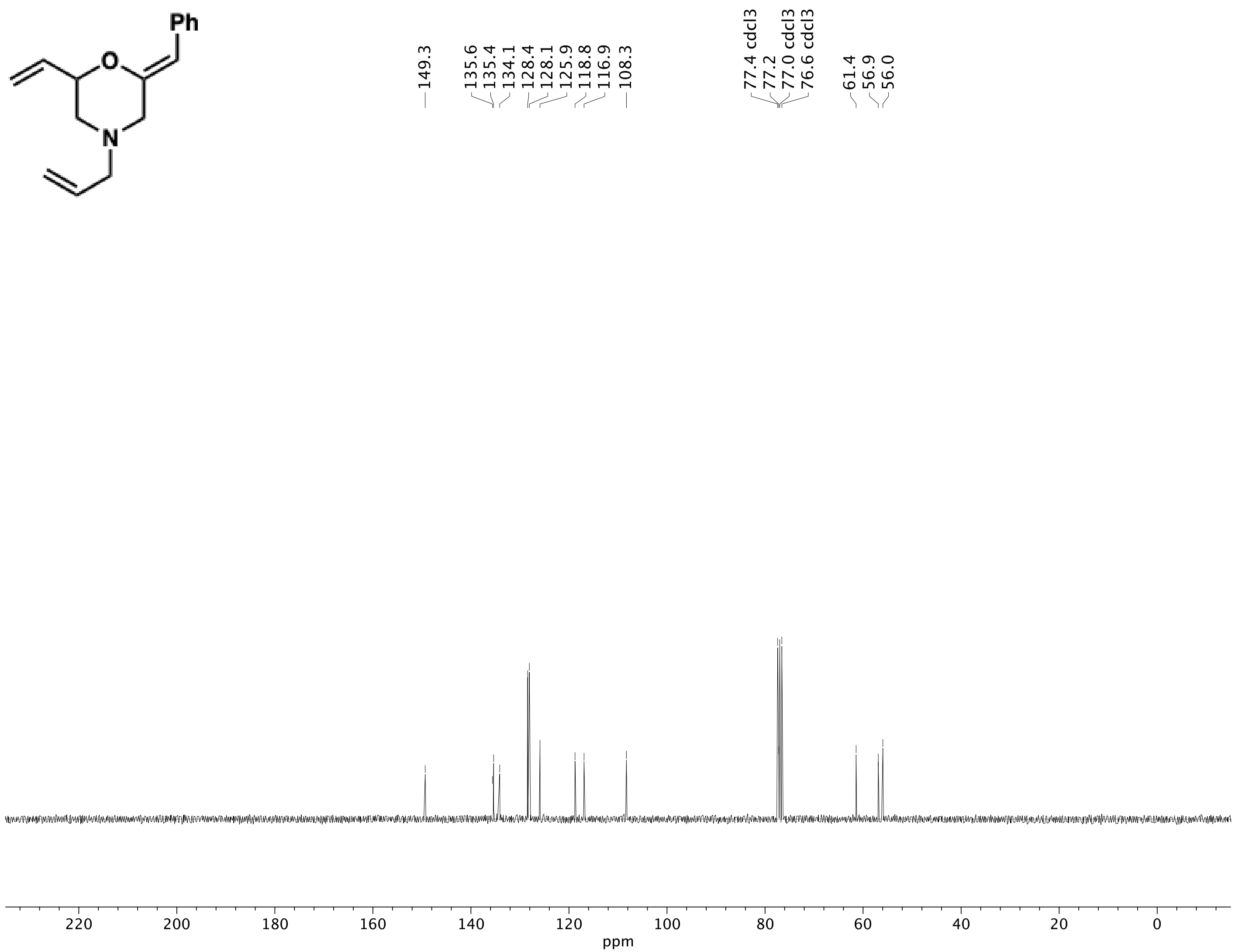
^{1}H NMR (300 MHz, $CDCl_3$) of compound **2n**.



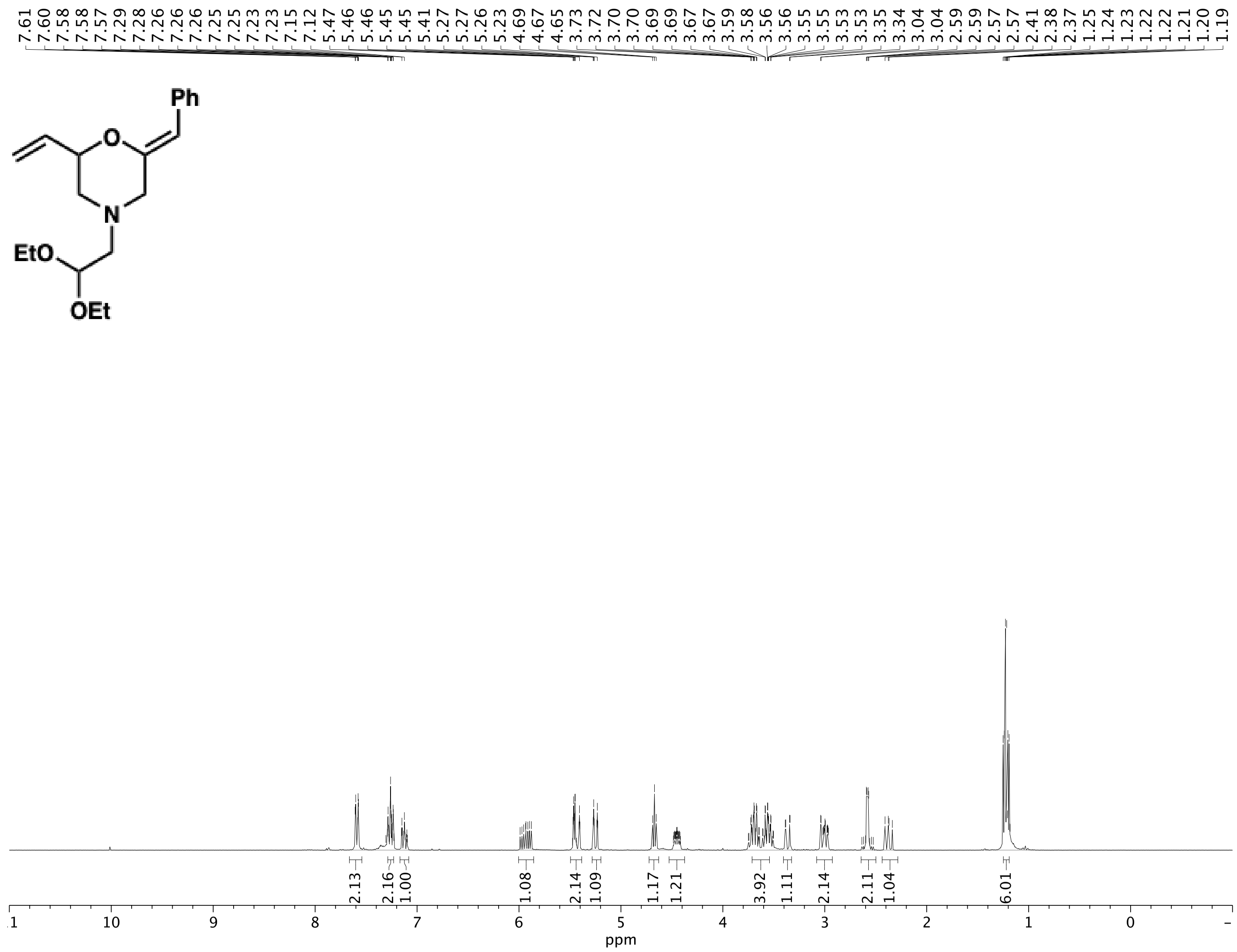
^{13}C NMR (101 MHz, $CDCl_3$) of compound **2n**.



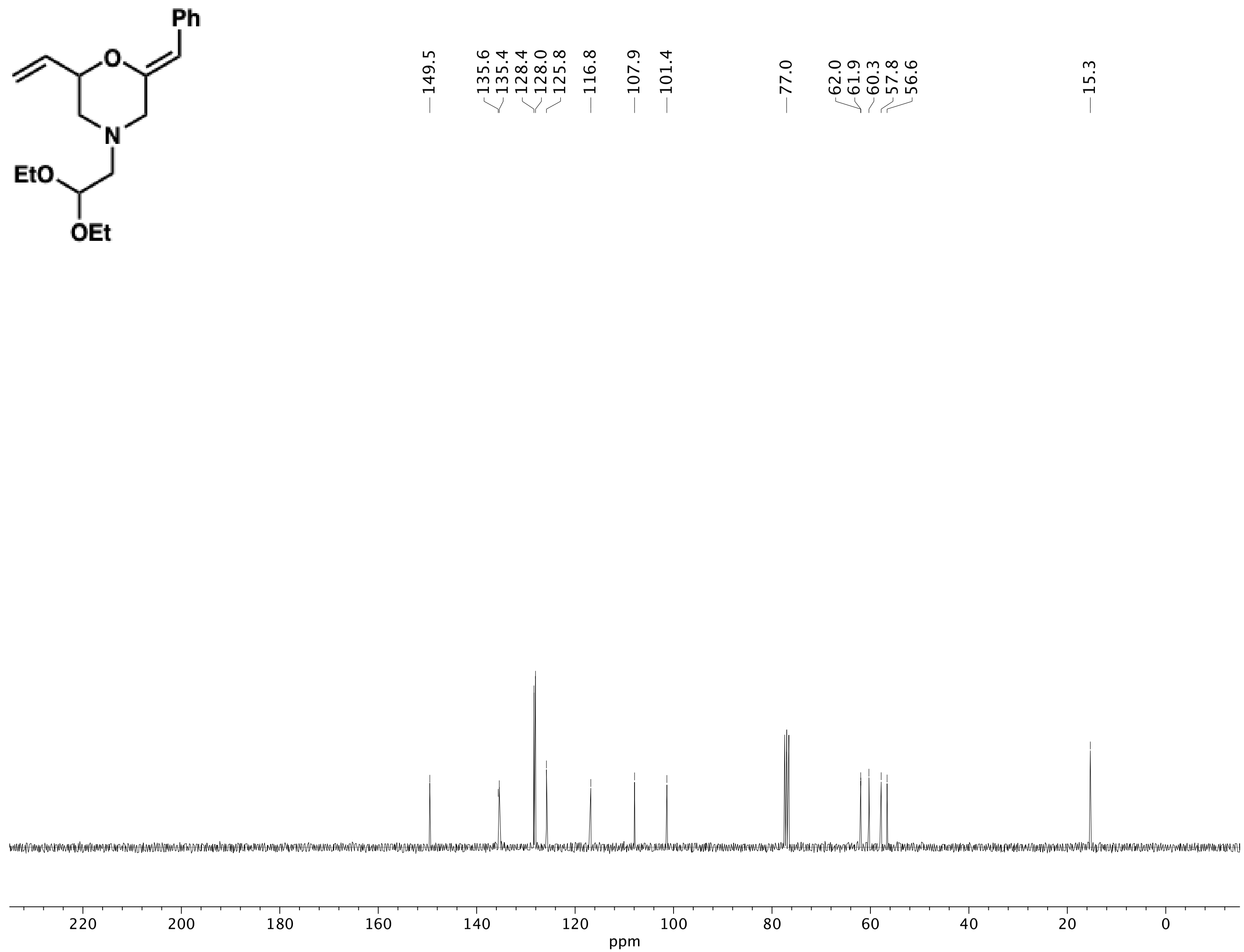
[1]H NMR (300 MHz, $CDCl_3$) of compound **2o**.



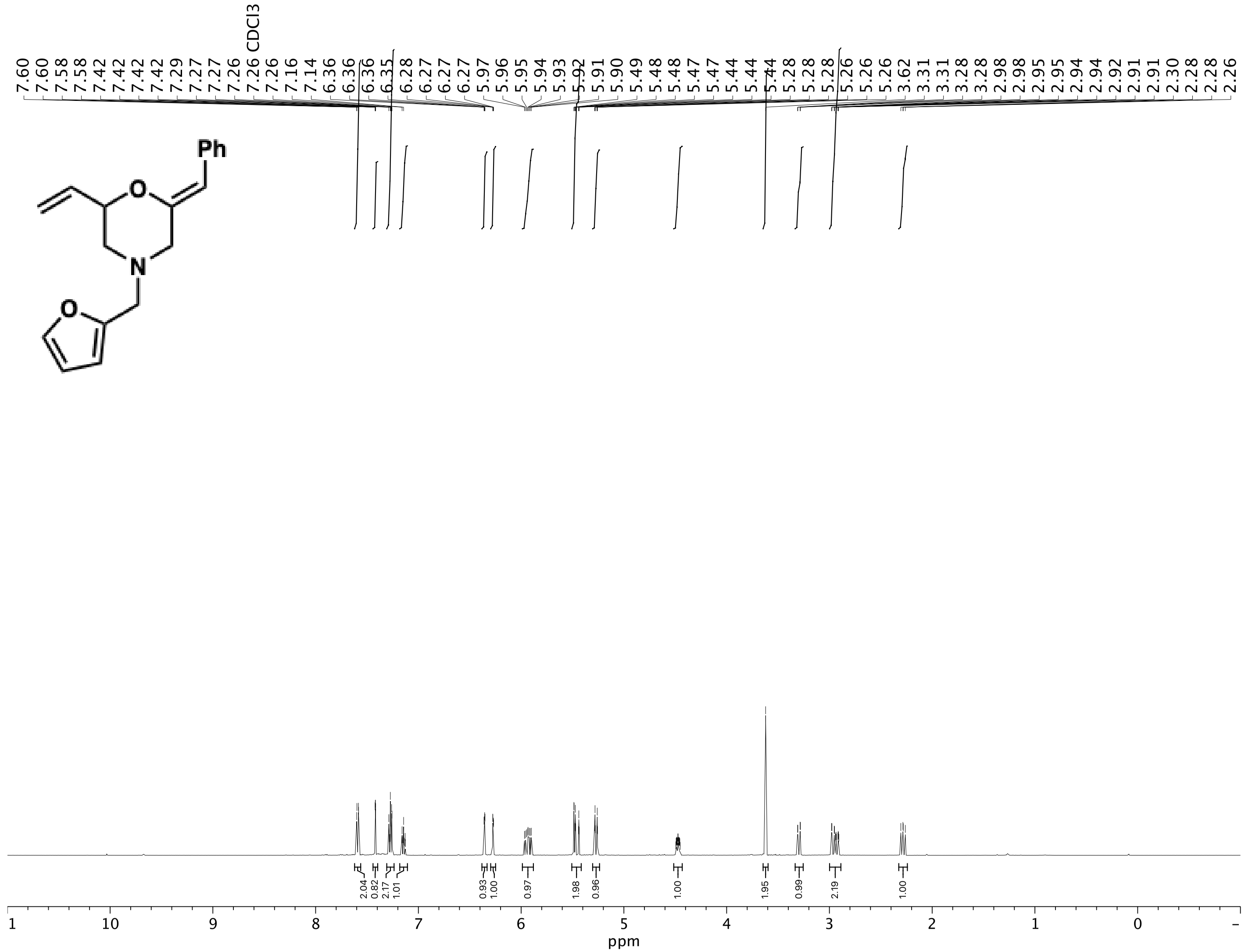
^{13}C NMR (75 MHz, $CDCl_3$) of compound **2o**.



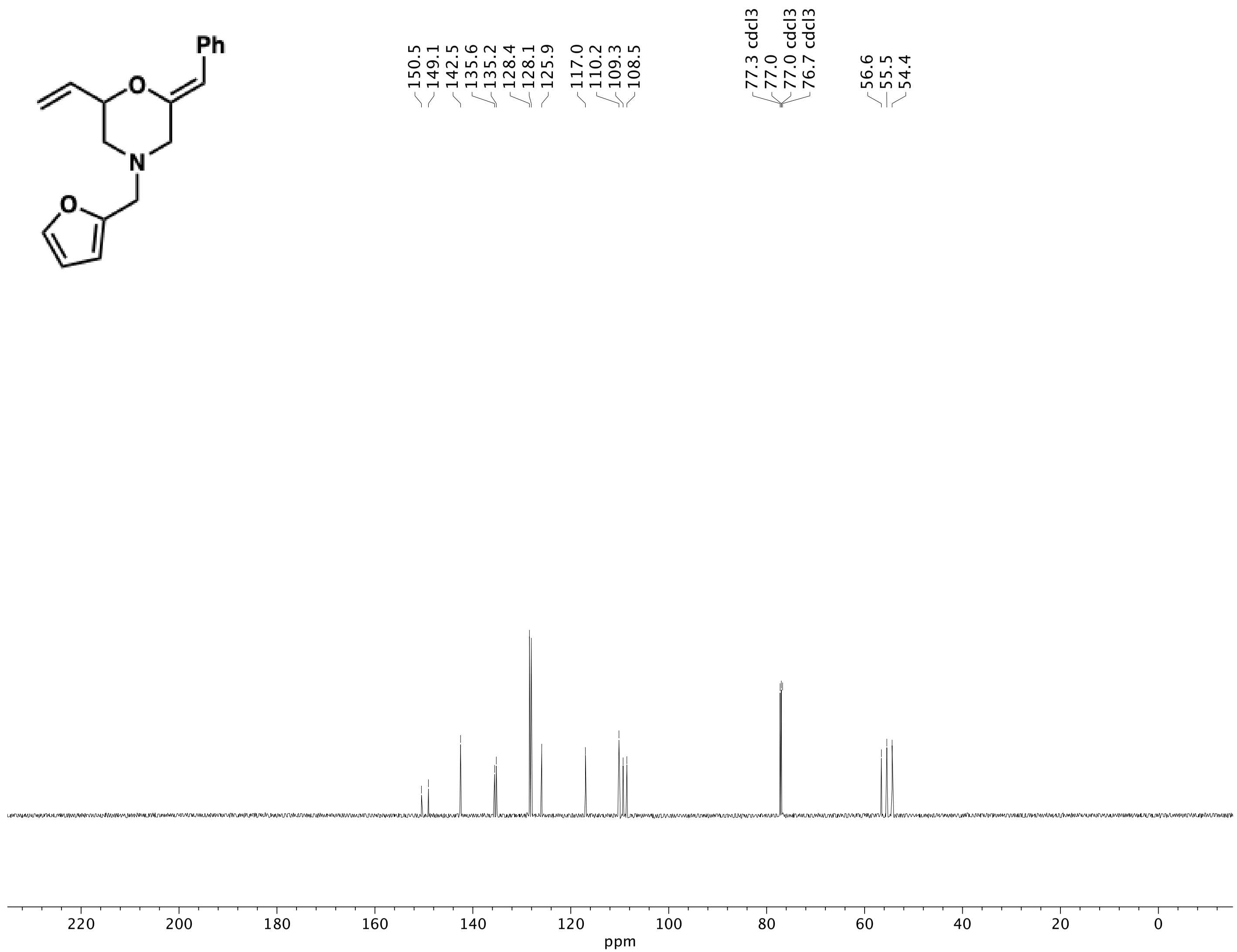
^{1}H NMR (300 MHz, $CDCl_3$) of compound **2p**.



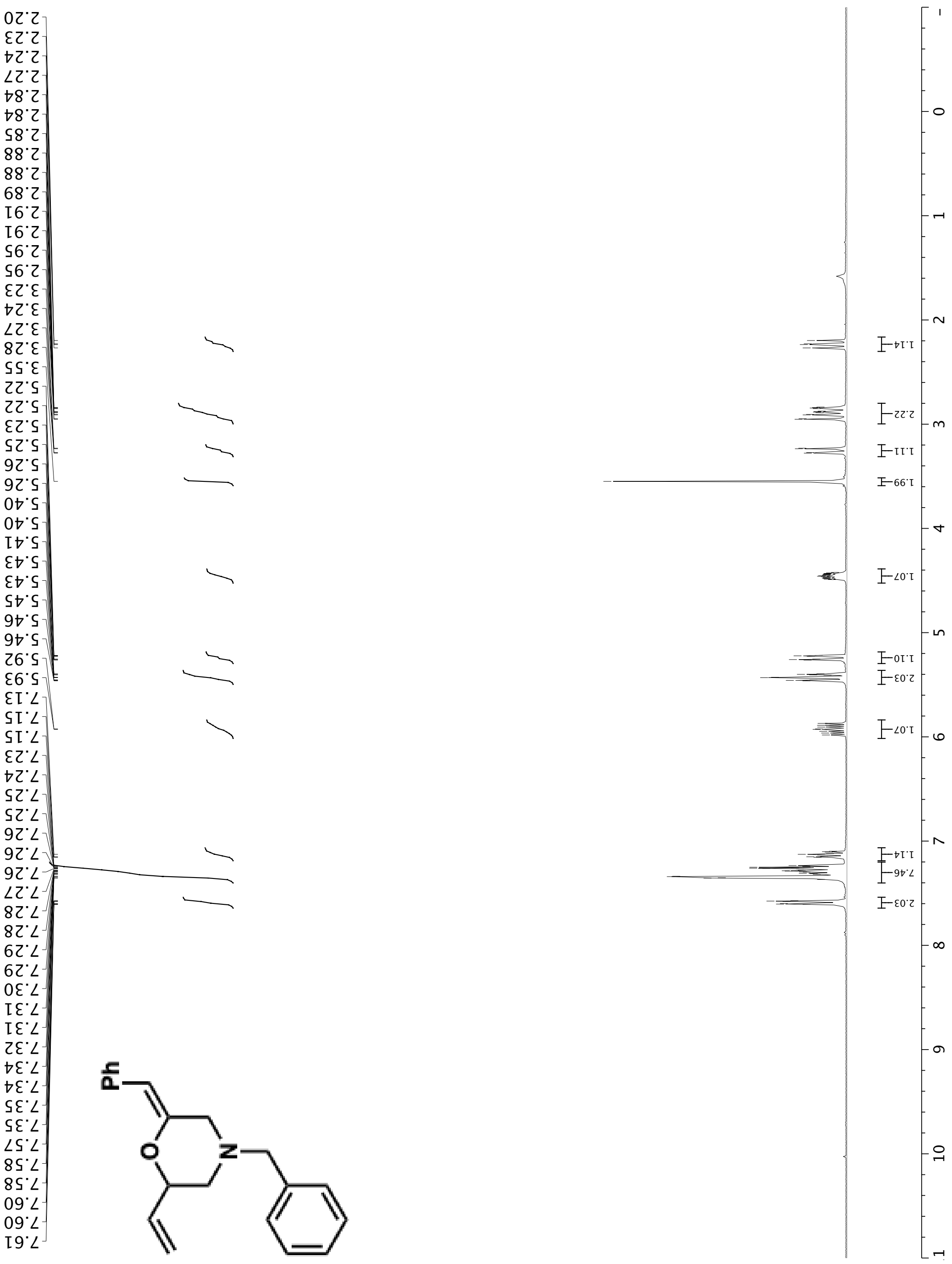
^{13}C NMR (75 MHz, $CDCl_3$) of compound **2p**.



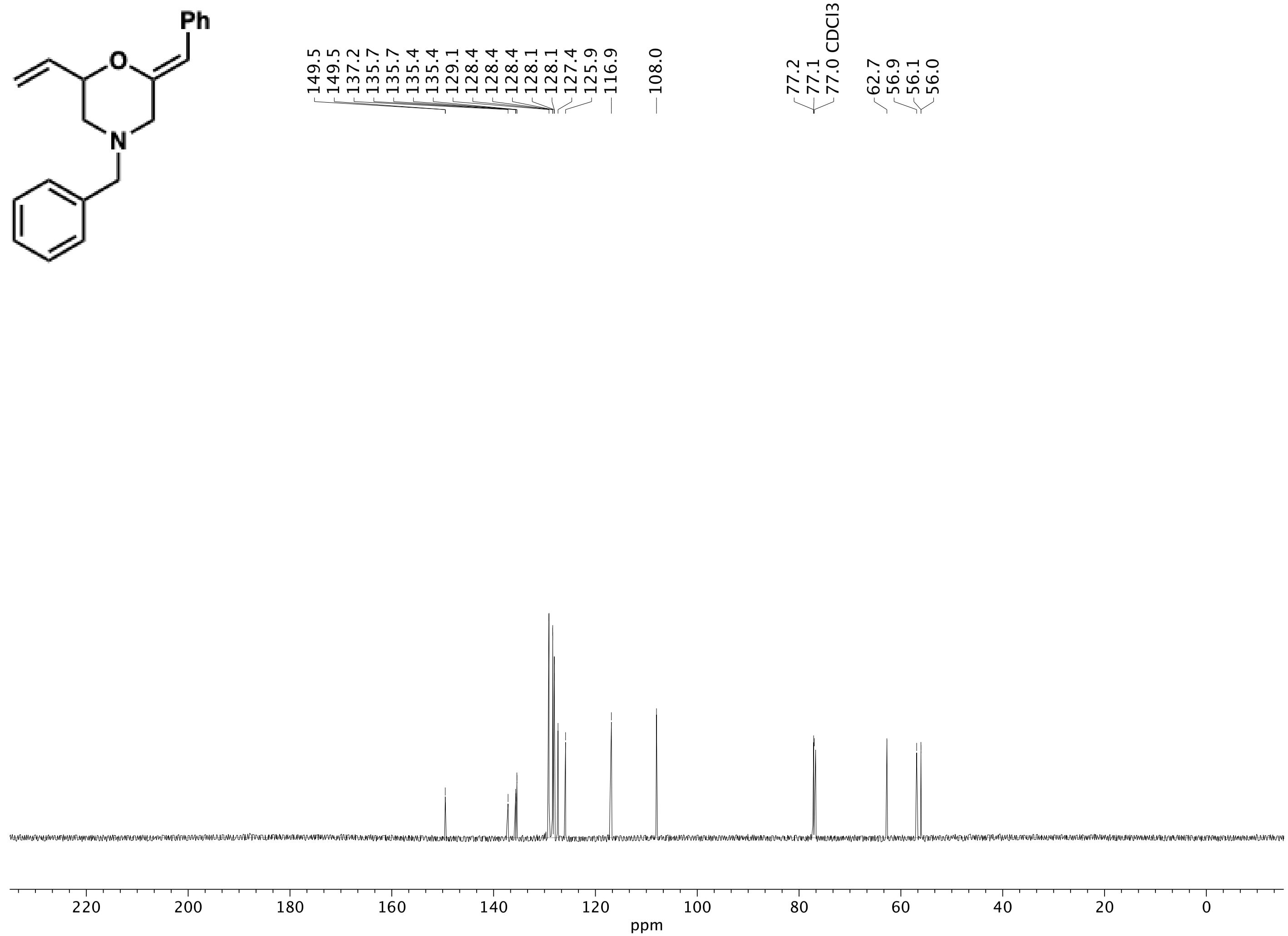
^{1}H NMR (500 MHz, $CDCl_3$) of compound **2q**.



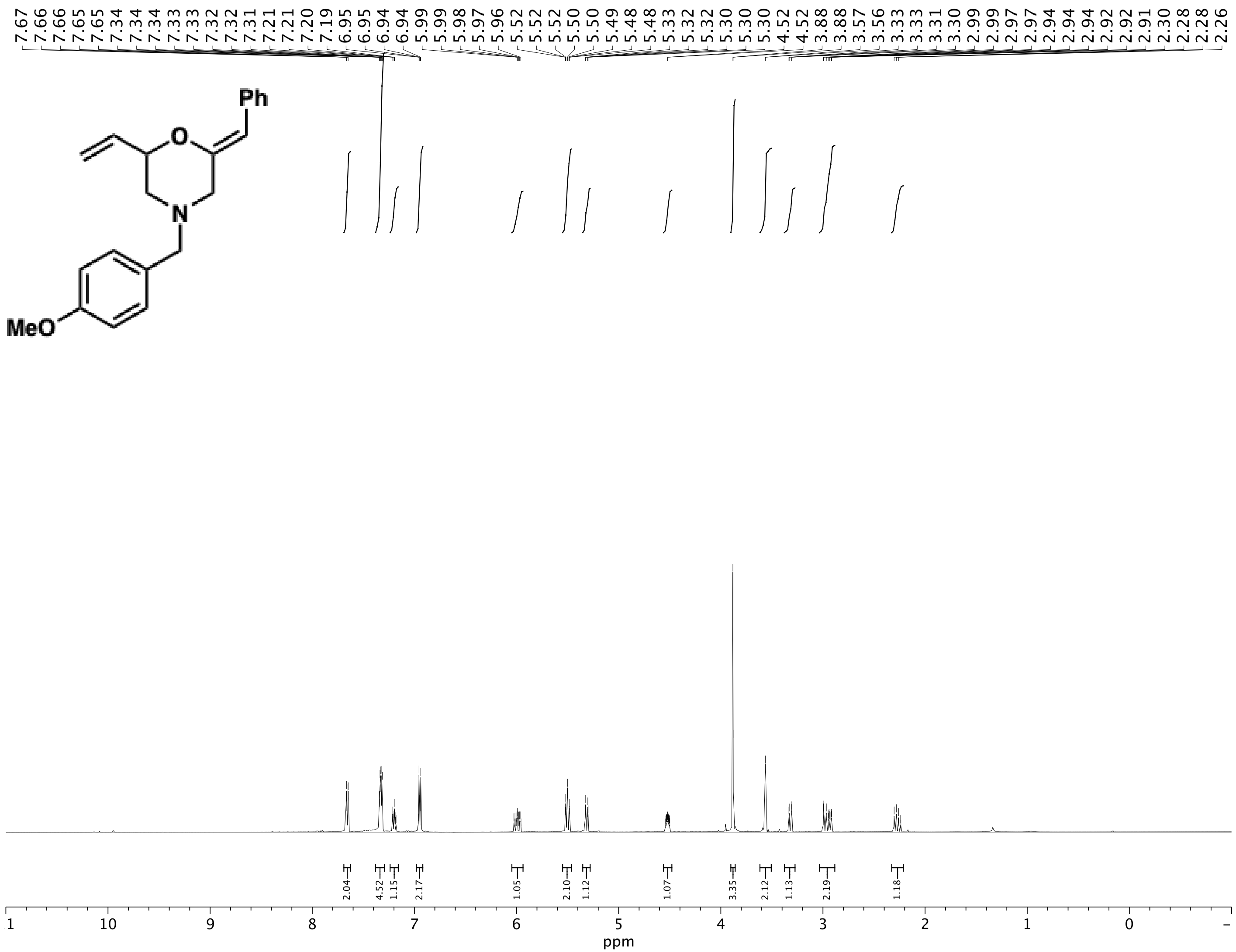
^{13}C NMR (126 MHz, $CDCl_3$) of compound **2q**.



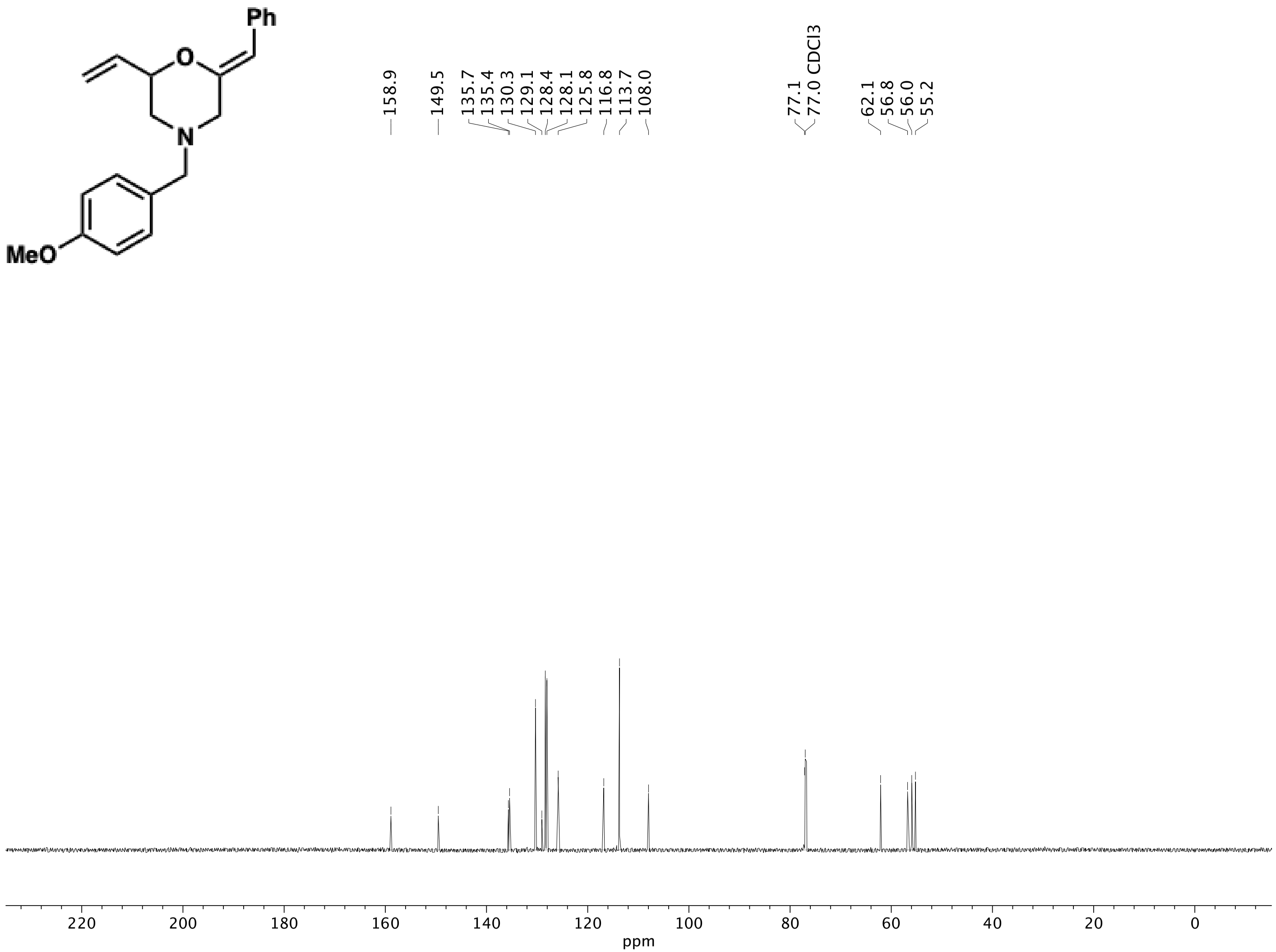
^{1}H NMR (300 MHz, $CDCl_3$) of compound **2r**.



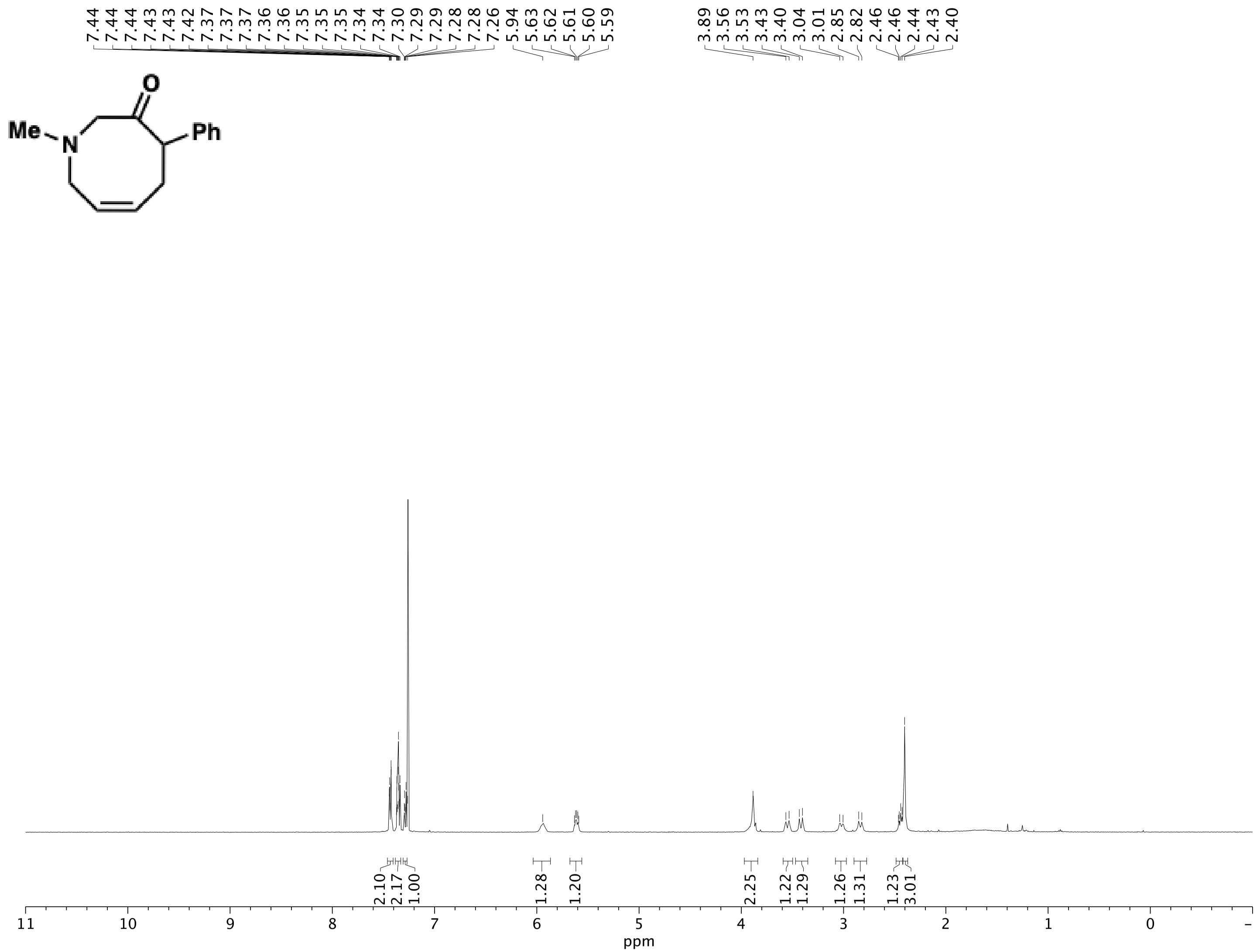
^{13}C NMR (126 MHz, $CDCl_3$) of compound **2r**.



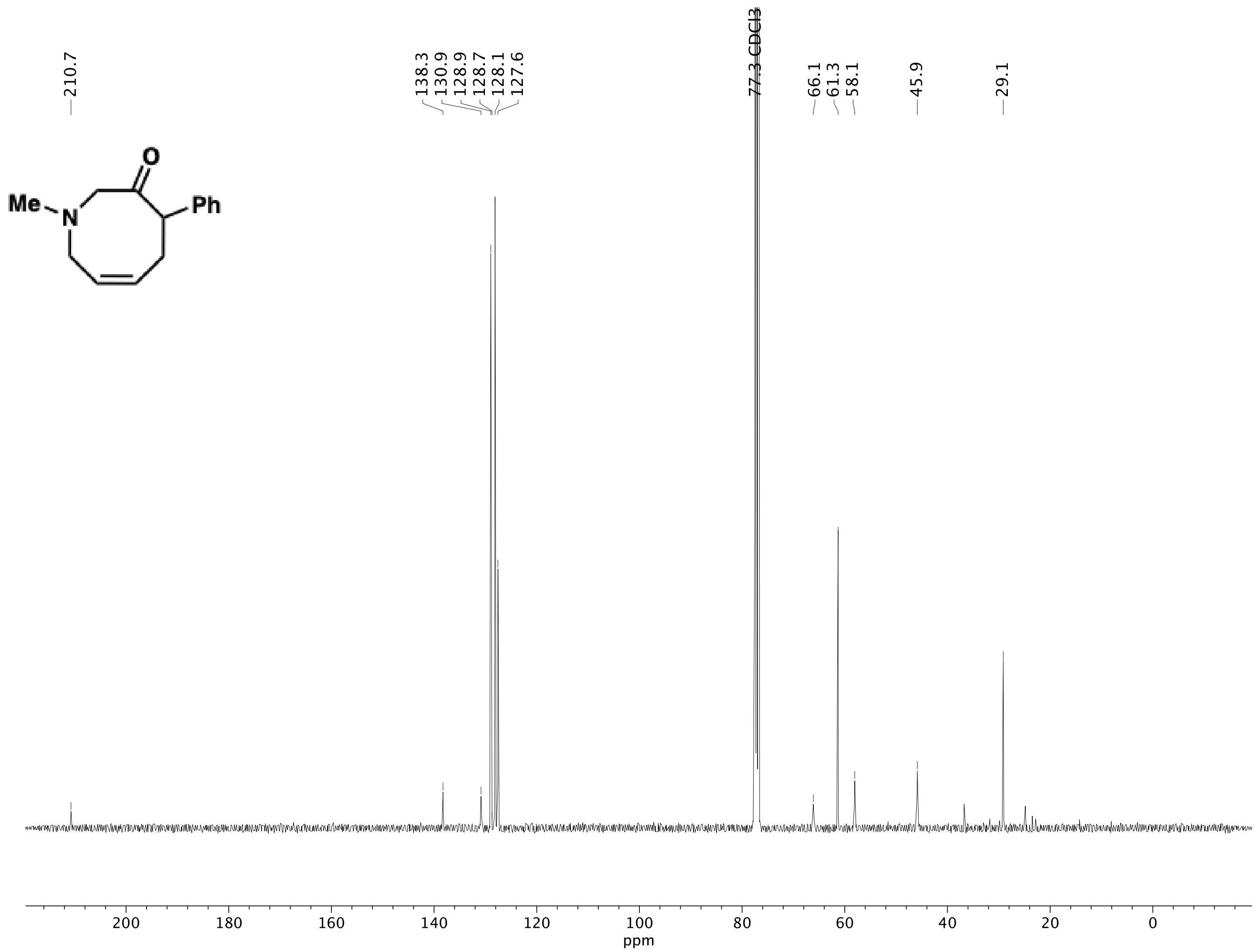
^{1}H NMR (500 MHz, $CDCl_3$) of compound **2s**.



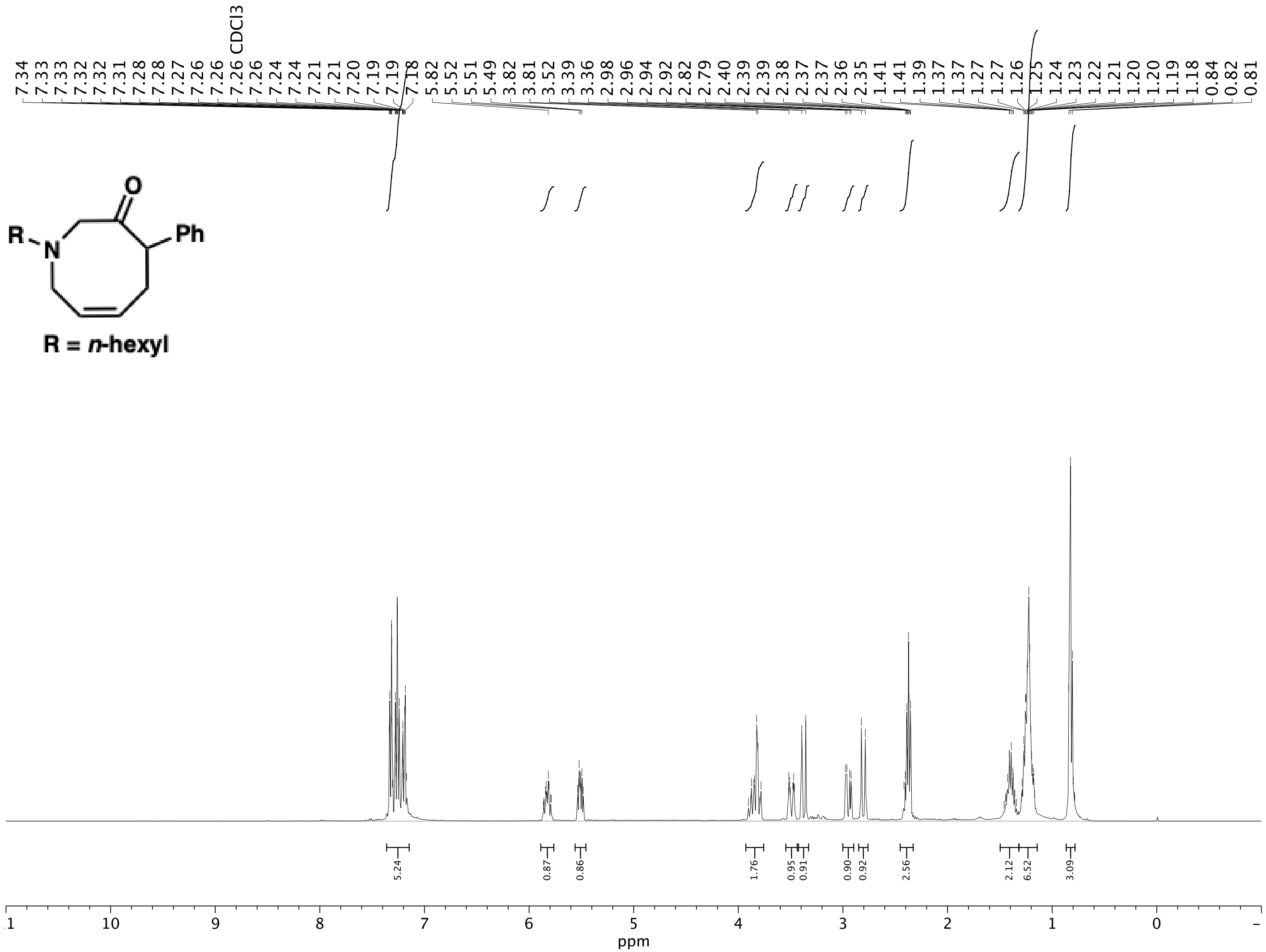
^{13}C NMR (126 MHz, $CDCl_3$) of compound **2s**.



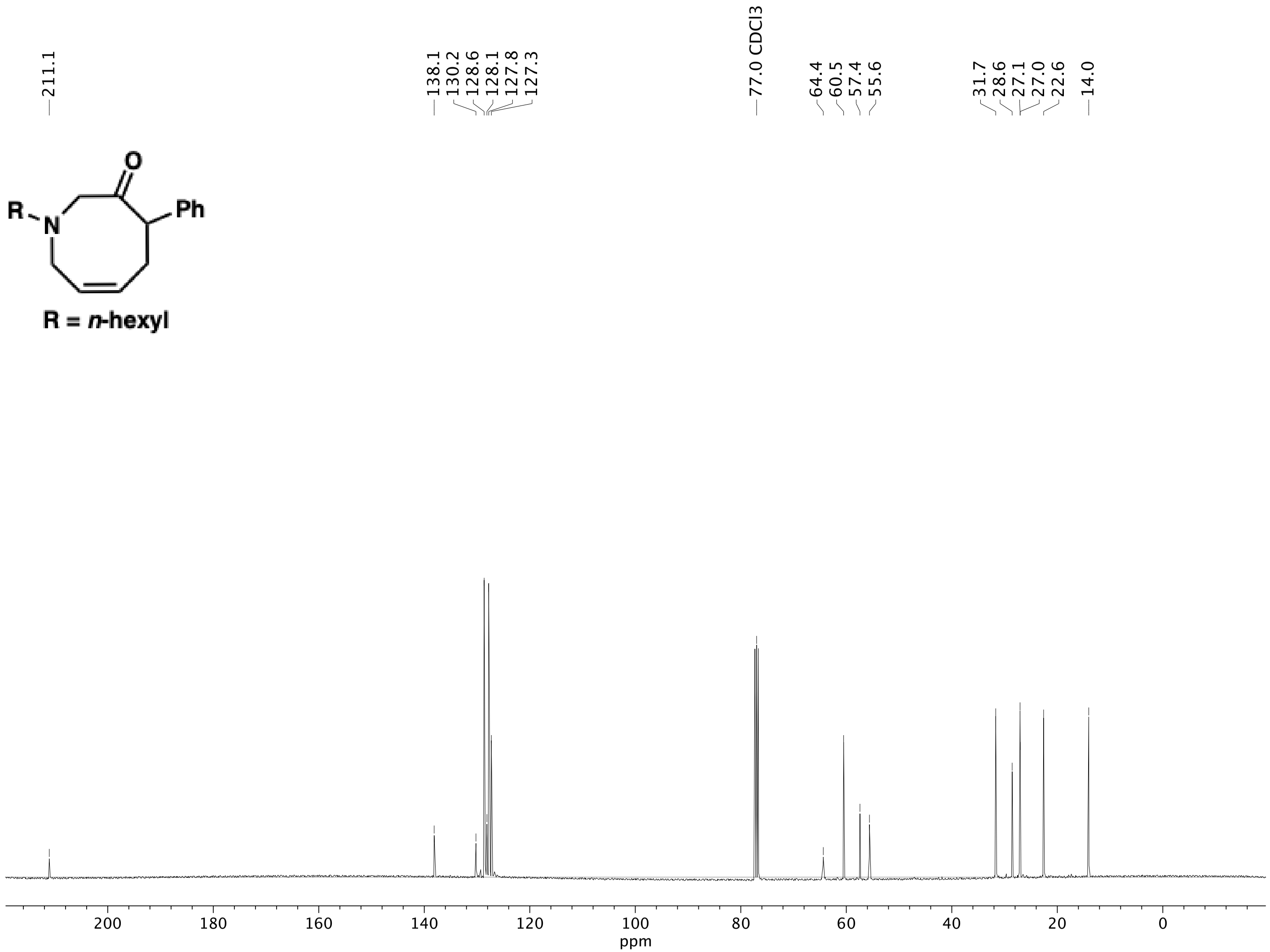
^{1}H NMR (500 MHz, $CDCl_3$) of compound **3l**.



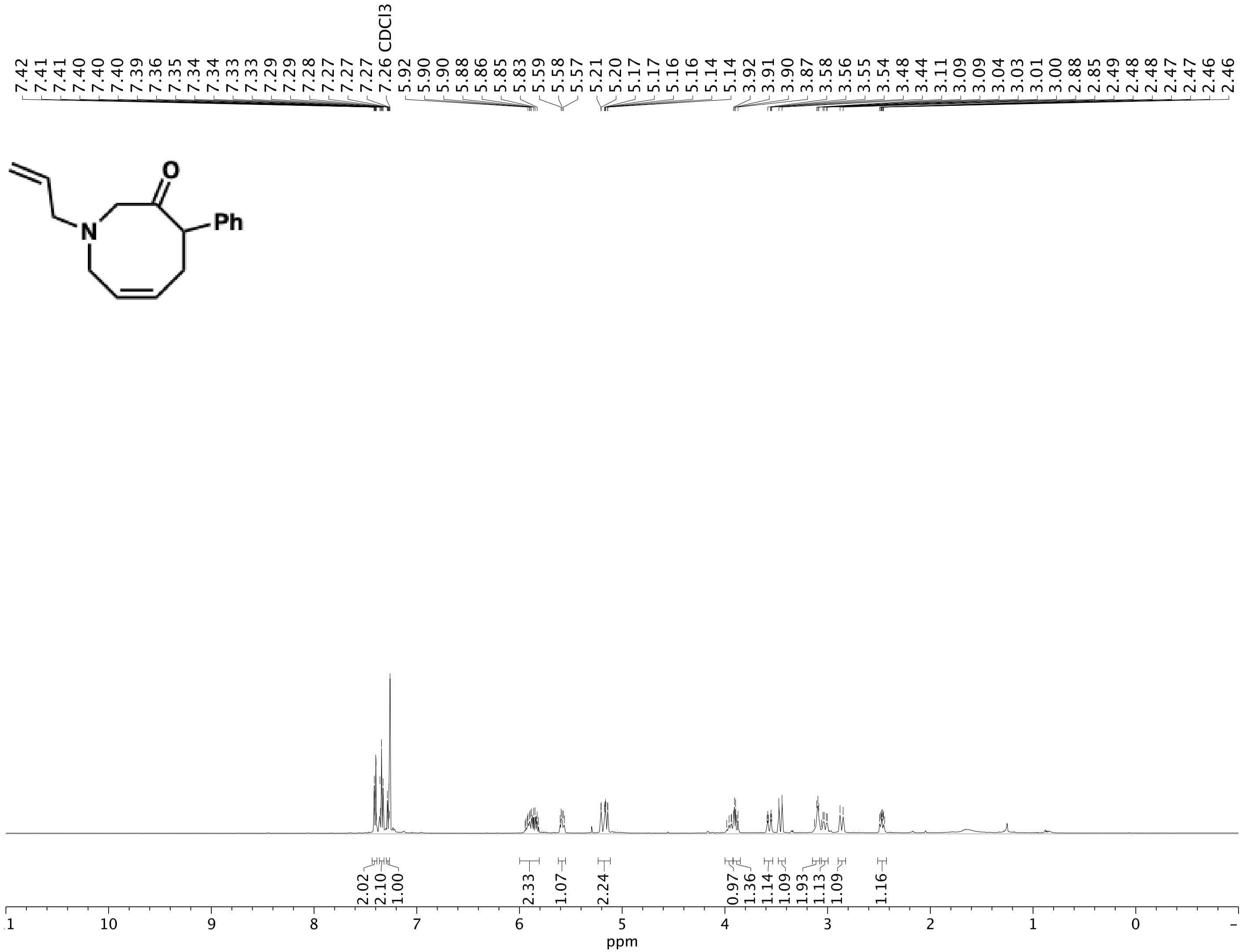
^{13}C NMR (101 MHz, $CDCl_3$) of compound **3l**.



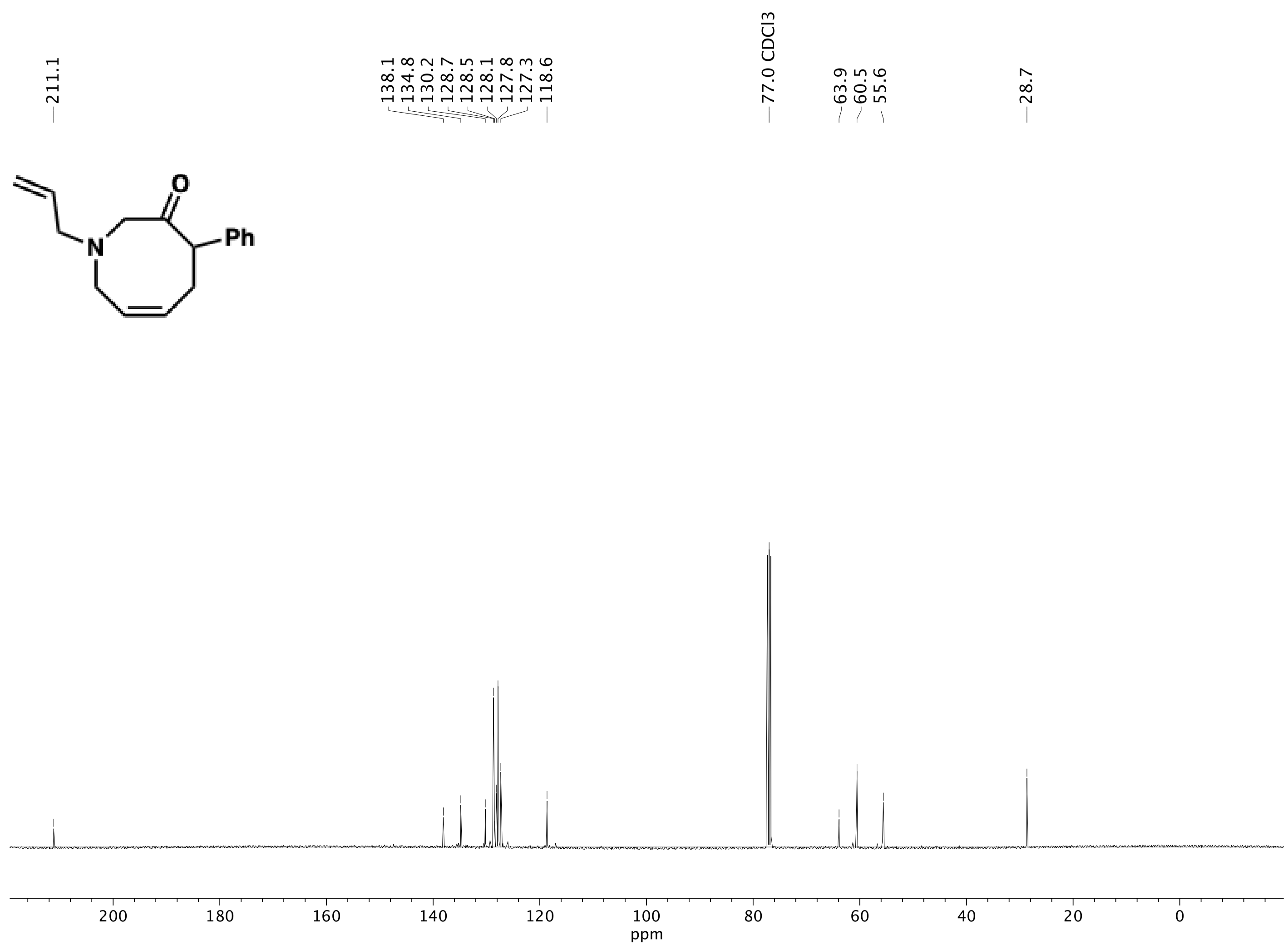
^{1}H NMR (400 MHz, $CDCl_3$) of compound **3n.**



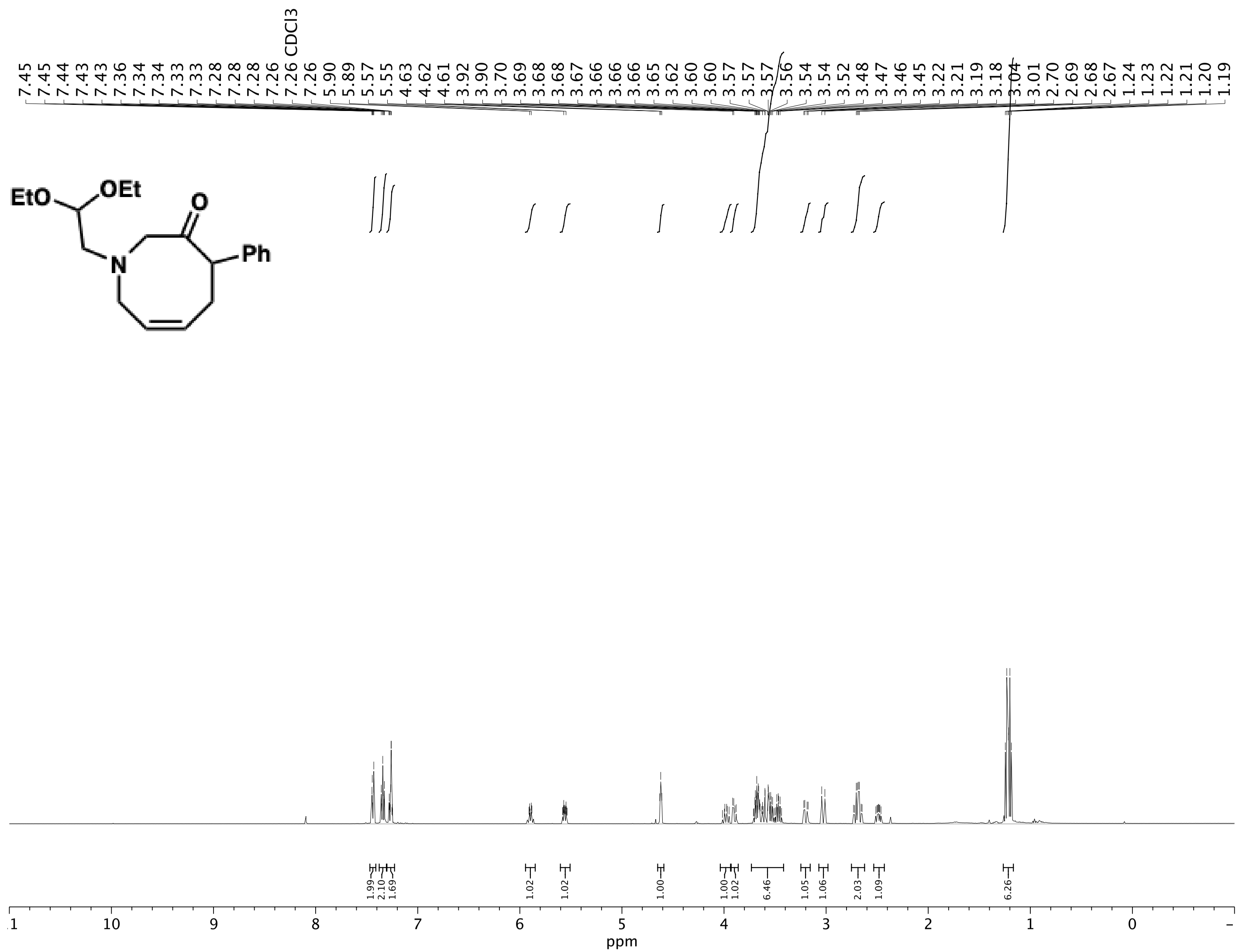
^{13}C NMR (101 MHz, $CDCl_3$) of compound **3n**.



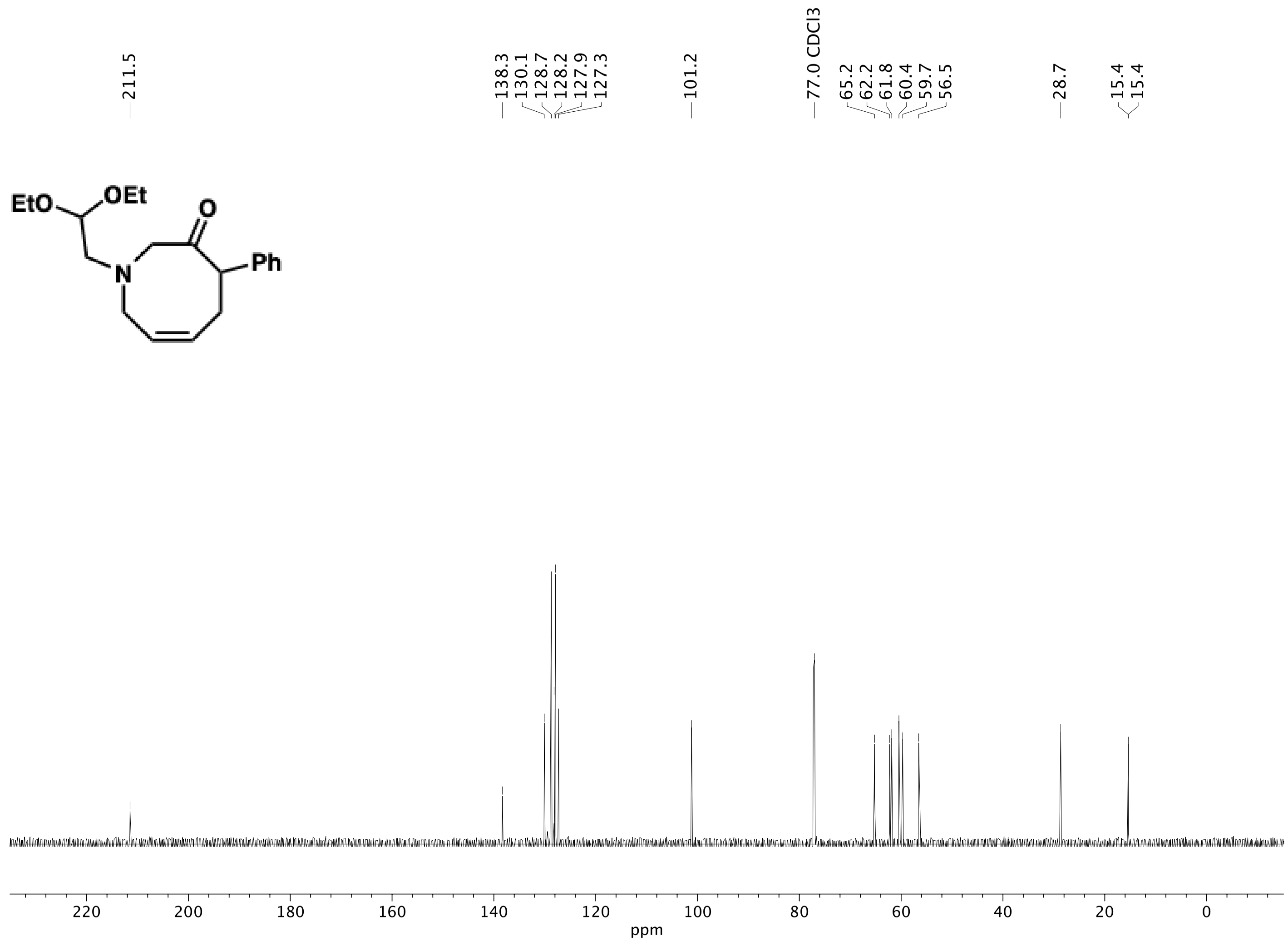
^1H NMR (500 MHz, $CDCl_3$) of compound **3o.**



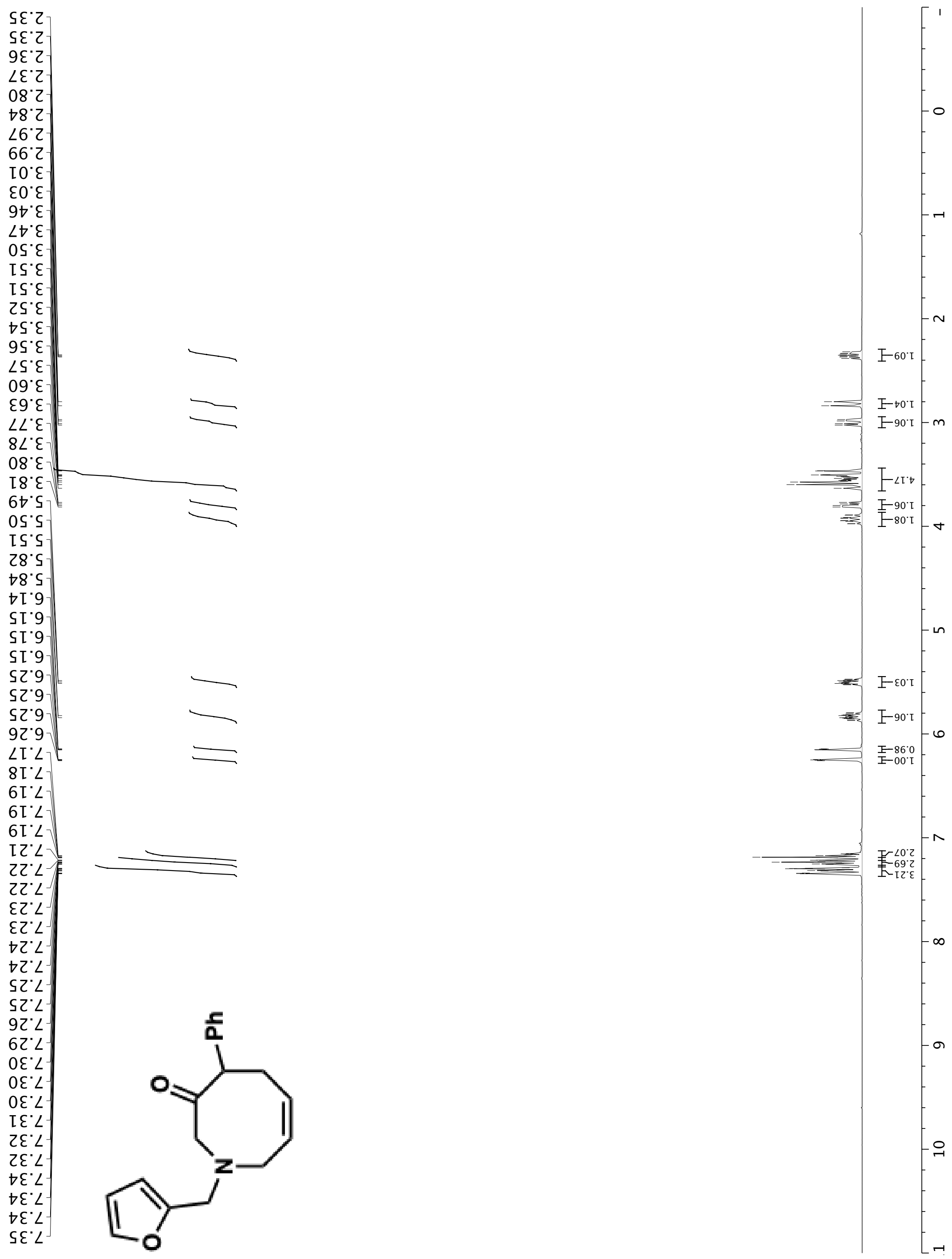
^{13}C NMR (101 MHz, $CDCl_3$) of compound **3o**.



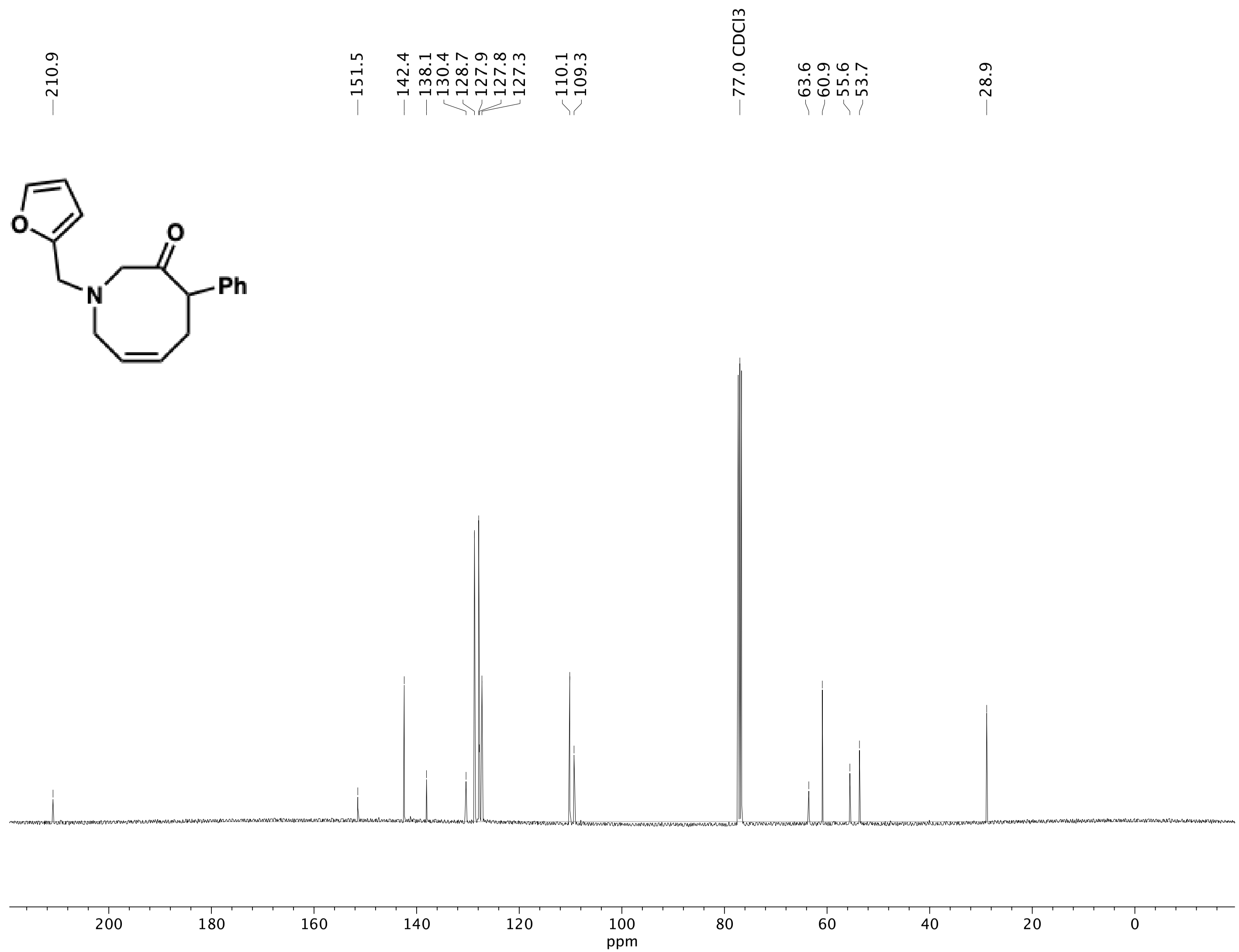
^{1}H NMR (500 MHz, $CDCl_3$) of compound **3p.**



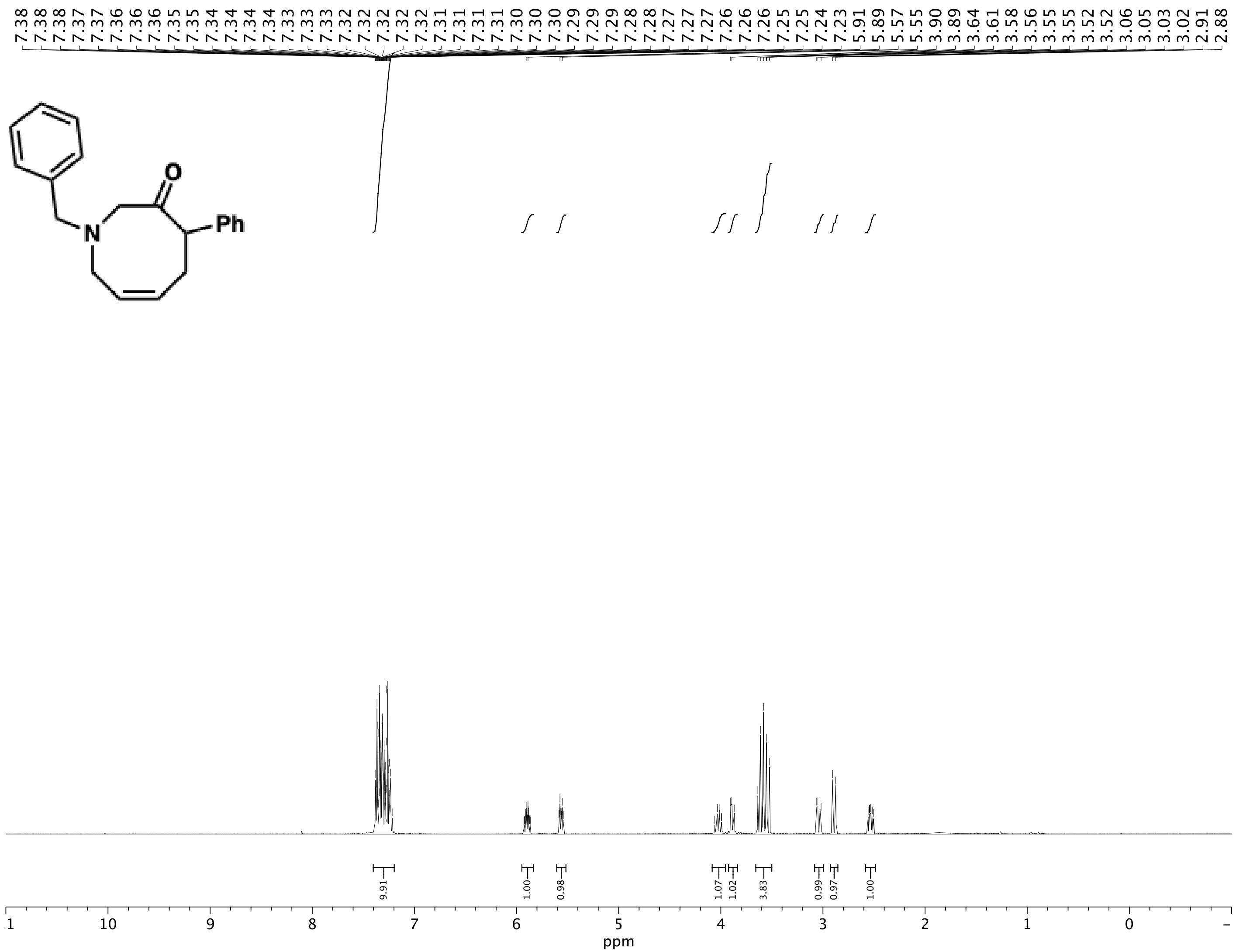
^{13}C NMR (126 MHz, $CDCl_3$) of compound **3p**.



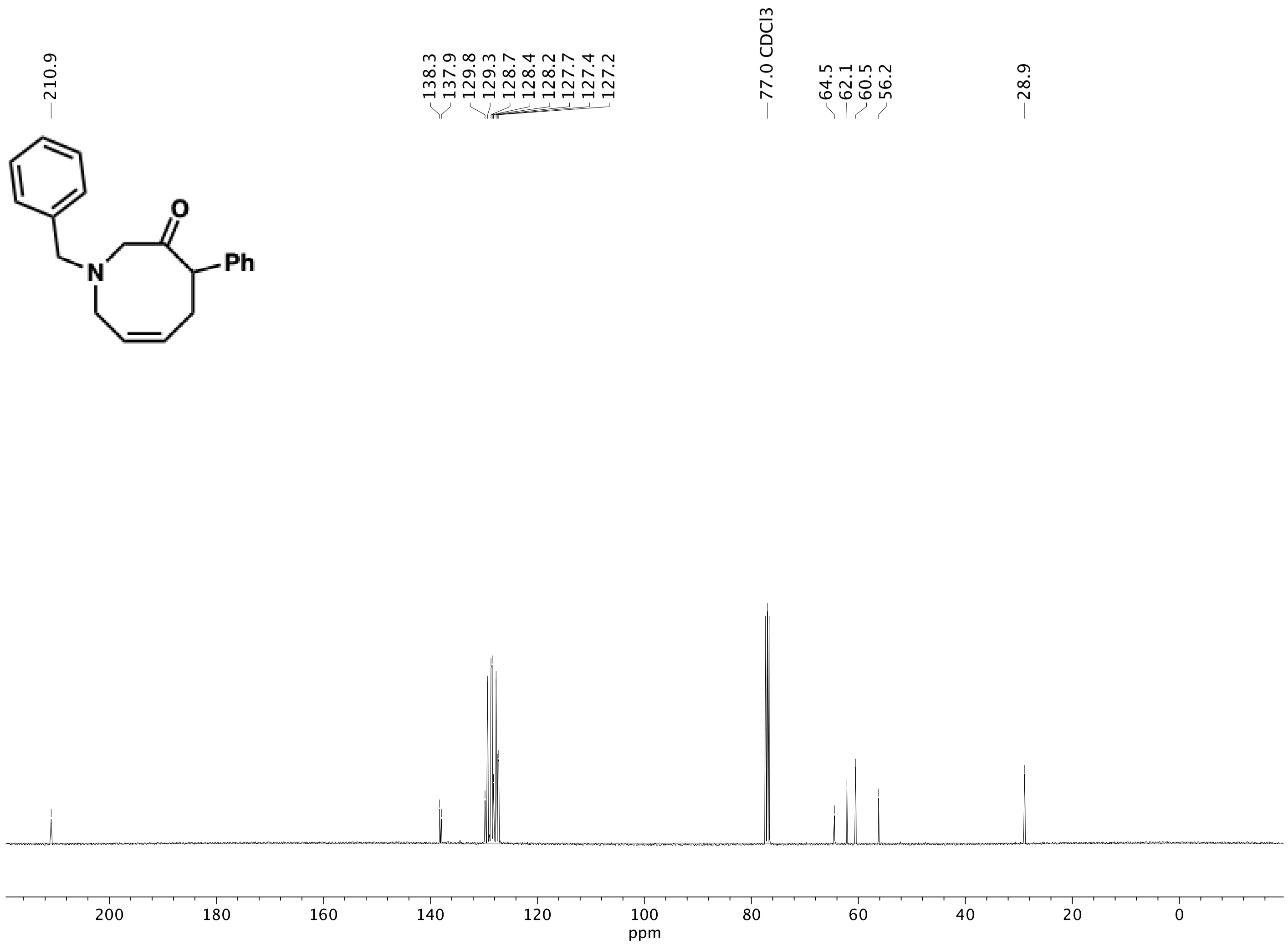
^{1}H NMR (400 MHz, $CDCl_3$) of compound **3q.**



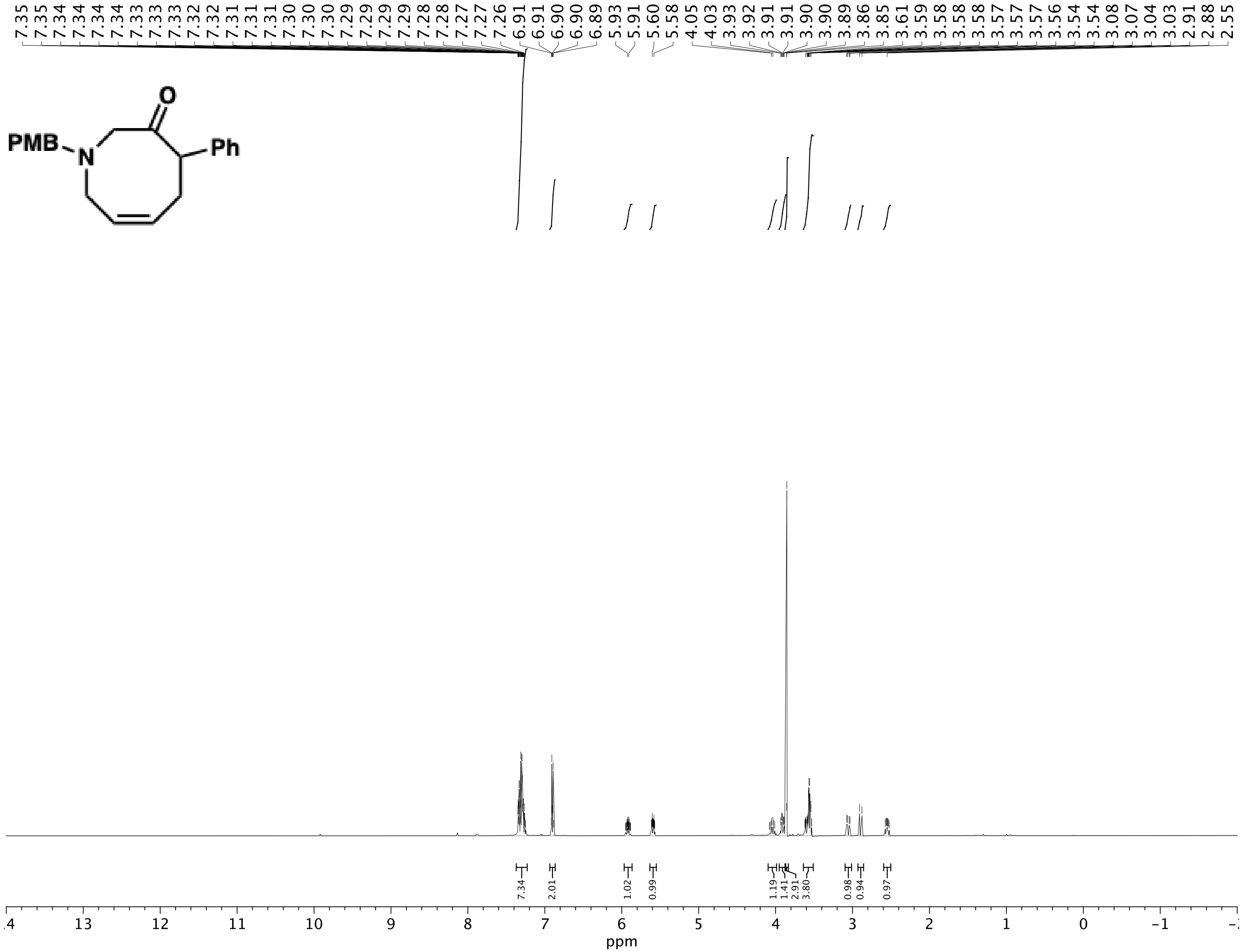
^{13}C NMR (101 MHz, $CDCl_3$) of compound **3q**.



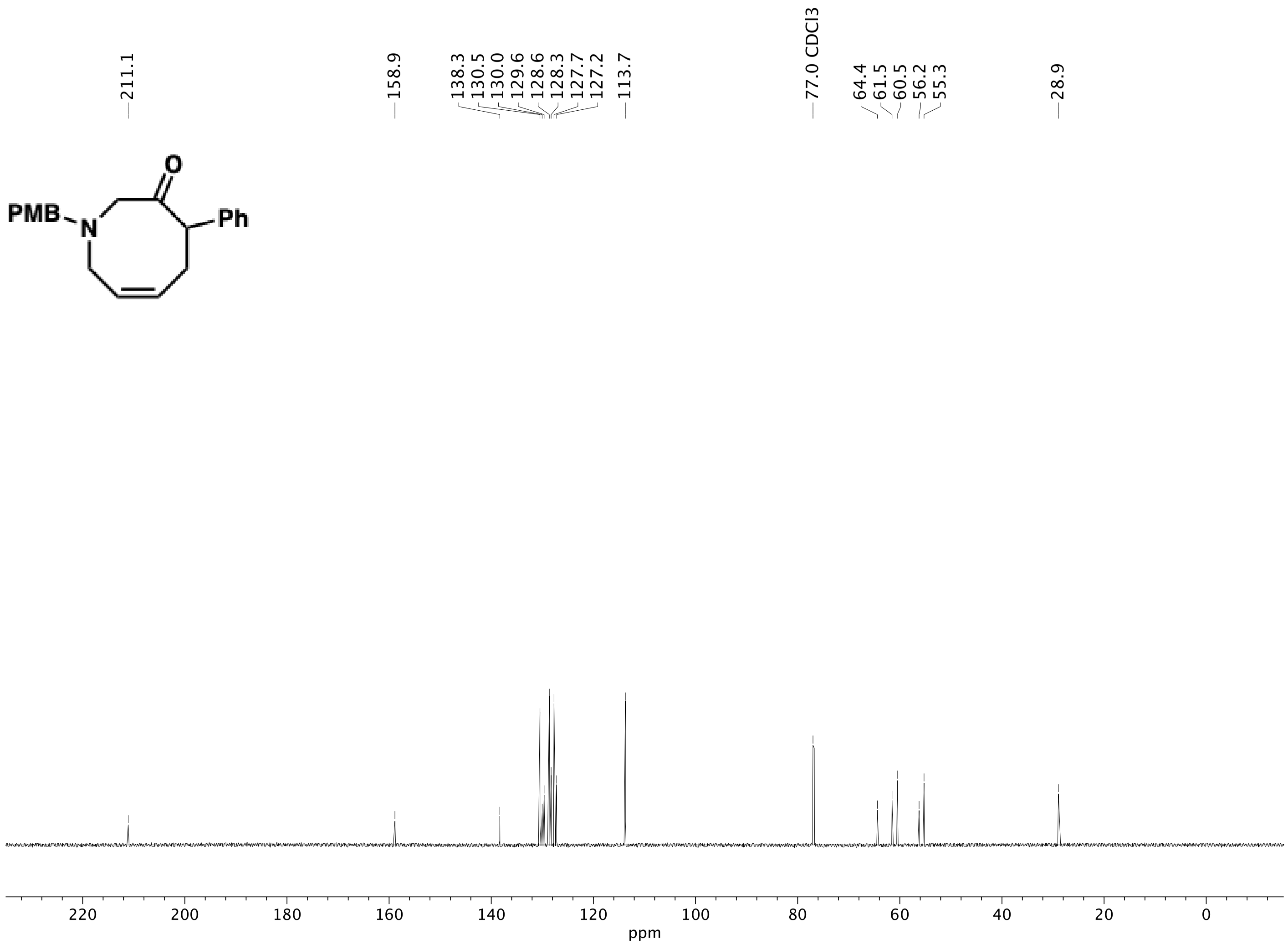
^{1}H NMR (500 MHz, $CDCl_3$) of compound **3r.**



^{13}C NMR (101 MHz, $CDCl_3$) of compound **3r**.



^{1}H NMR (500 MHz, $CDCl_3$) of compound **3s.**



^{13}C NMR (126 MHz, $CDCl_3$) of compound **3s**.